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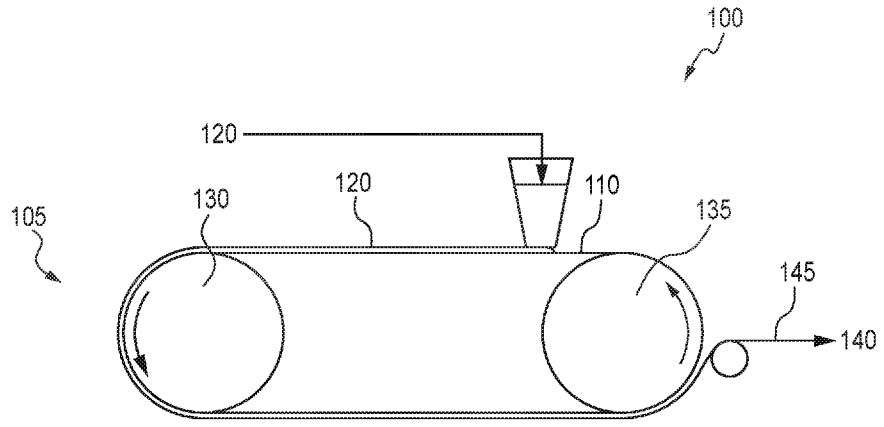

FIG. 1

(57) Abstract: Textured films and laminates using such films are described. The outer face of the film exhibits a textured surface. In many versions, the films and laminates additionally include an adhesive layer. Also described are various methods for producing the textured films.

WO 2019/169079 A1

EXTREME TEXTURED FILMS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Patent Application No. 62/637,011, filed March 1, 2018, which is incorporated herein by reference in its entirety.

FIELD

[0002] The present subject matter relates to textured films which are durable and resistant to wear. The present subject matter also provides methods for producing the textured films. Additionally, the present subject matter relates to laminates utilizing the textured films. The films can be applied to vehicles or other substrates and provide a textured appearance and/or functionality.

BACKGROUND

[0003] Vehicle wraps are a well-known means of decorating and/or placing advertising on vehicles such as vans, cars, trucks, trailers, buses, recreational vehicles, etc. (collectively, “vehicles” hereinafter). In brief, a vehicle wrap is a plastic sheet typically vinyl or other conformable material upon which a graphical image has been printed. The wrap is preferably removably affixed (e.g., via adhesive) to the exterior of a vehicle, thereby suggesting that the vehicle has been custom painted. One advantage of a vehicle wrap is that the wrap can be removed, and the design changed unlike a painted solution.

[0004] In certain applications, it may be desirable to provide a textured surface on certain regions or components of a vehicle. Textured surfaces can improve traction, reduce slipping, and additionally provide a particular aesthetic appearance which may be desired. For example, textured coatings are known which are spray-applied as "bed liners" for trucks. Although satisfactory in many regards, once applied such coatings are difficult to remove.

[0005] Accordingly, a need exists for articles that provide a textured surface, and which can be removably applied to a wide array of substrates and particularly on vehicles.

SUMMARY

[0006] The difficulties and drawbacks associated with previous approaches are addressed in the present subject matter as follows.

[0007] In one aspect, the present subject matter provides a textured polymeric film defining a textured outer face and an oppositely directed inner face. The outer face includes a plurality of projections, wherein at least 90% of the projections exhibit a feature depth within a range of from 12 microns to 150 microns.

[0008] In another aspect, the present subject matter provides a process for producing a textured polymeric film. The process comprises providing a textured casting sheet having an outer surface including a plurality of depressions. At least 90% of the depressions exhibit a feature depth within a range of from 12 microns to 150 microns. The process also comprises depositing a flowable polymeric composition onto the outer surface of the casting sheet to form a layer thereon. The process additionally comprises solidifying the layer of the polymeric composition to thereby form a textured polymeric film.

[0009] In another aspect, the present subject matter provides a process for producing a textured polymeric film. The process comprises providing a casting sheet having an outer surface. The process also comprises depositing a flowable polymeric composition onto the outer surface of the casting sheet to form a layer thereon. The process further comprises at least partially solidifying the layer of the polymeric composition to thereby form an intermediate film. The process additionally comprises providing a heated embossing roll defining a circumferential textured outer face including a plurality of depressions, wherein at least 90% of the depressions exhibit a feature depth within a range of from 12 microns to 150 microns. And, the process comprises contacting the intermediate film with the heated embossing roll to thereby form a textured polymeric film.

[0010] In still another aspect, the present subject matter provides a process for producing a textured polymeric film. The process comprises providing a casting sheet having an outer surface. The process also comprises depositing a flowable polymeric composition onto the outer surface of the casting sheet to form a layer thereon. The process additionally comprises at least partially solidifying the layer of the polymeric composition to thereby form an intermediate film. And the process also comprises depositing a secondary material onto an outer surface of the intermediate film to thereby form a textured polymeric film, wherein an outer face of the textured polymeric film includes a plurality of projections, and at least 90% of the projections exhibit a feature depth within a range of from 12 microns to 150 microns.

[0011] In still another aspect, the present subject matter provides a process for producing a textured polymeric film. The process comprises providing a casting sheet having an outer surface. The process also comprises depositing a flowable polymeric composition onto the outer surface of the casting sheet to form a layer thereon. The process also comprises at least partially solidifying the layer of the polymeric composition to thereby form an intermediate film. The process further comprises depositing particulate material onto an outer face of the intermediate film. The process further comprises at least partially embedding at least a portion of the particulate material into the outer face of the intermediate film to thereby form a modified intermediate film. The process additionally comprises depositing a coating material onto the particulate material and the outer face of the modified intermediate film. And, the process comprises solidifying the coating material deposited on the particulate material and the outer face of the modified intermediate film to thereby form a textured polymeric film. The deposited coating material constitutes a textured outer face of the textured polymeric film. The textured outer face includes a plurality of projections, wherein at least 90% of the projections exhibit a feature depth within a range of from 12 microns to 150 microns.

[0012] In still another aspect, the present subject matter provides a process for producing a textured polymeric film. The process comprises providing a casting sheet having an outer surface. The process also comprises depositing a flowable polymeric composition onto the outer surface of the casting sheet to form a layer thereon. The polymeric composition can further comprising a blowing agent. The blowing agent can be a thermally activated blowing agent, such as an expandable microsphere. The process can further comprise at least partially solidifying the layer of the polymeric composition to thereby form an intermediate film. The process can further comprise heating the intermediate film (e.g., to a temperature of from 80°C to 190°C, such as from 80°C to 130°C) to activate the blowing agent, thereby forming a textured polymeric film. The textured polymeric film can define a textured outer face and an oppositely directed inner face, the outer face including a plurality of projections, wherein at least 90% of the projections exhibit a feature depth of from 12 microns to 150 microns.

[0013] In yet further aspects, the present subject matter also provides various textured films produced using the noted processes.

[0014] In yet another aspect, the present subject matter provides a laminate comprising a textured polymeric film defining a textured outer face and an oppositely directed inner face. The textured outer face of the film includes a plurality of projections, wherein at least 90% of the projections exhibit a feature depth within a range of from 12 microns to 150 microns. The laminate also comprises adhesive disposed on the inner face of the film.

[0015] As will be realized, the subject matter described herein is capable of other and different embodiments and its several details are capable of modifications in various respects, all without departing from the claimed subject matter. Accordingly, the drawings and description are to be regarded as illustrative and not restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Figure 1 is a schematic illustration of a system and process for forming a textured film in accordance with an embodiment of the present subject matter.

[0017] Figure 2 is a schematic cross-sectional view of a textured film in accordance with an embodiment of the present subject matter.

[0018] Figure 3 is a schematic illustration of a system and process for forming a textured film in accordance with an embodiment of the present subject matter.

[0019] Figure 4 is a schematic cross-sectional view of an intermediate film in accordance with an embodiment of the present subject matter.

[0020] Figure 5 is a schematic cross-sectional view of a textured film in accordance with an embodiment of the present subject matter.

[0021] Figure 6 is a schematic illustration of a system and process for forming a textured film in accordance with an embodiment of the present subject matter.

[0022] Figure 7 is a schematic cross-sectional view of an intermediate film in accordance with an embodiment of the present subject matter.

[0023] Figure 8 is a schematic cross-sectional view of a textured film in accordance with an embodiment of the present subject matter.

[0024] Figure 9 is a schematic illustration of a system and process for forming a textured film in accordance with an embodiment of the present subject matter.

[0025] Figure 10 is a schematic cross-sectional view of an intermediate film in accordance with an embodiment of the present subject matter.

[0026] Figure 11 is a schematic cross-sectional view of a modified intermediate film in accordance with an embodiment of the present subject matter.

[0027] Figure 12 is a schematic cross-sectional view of a textured film in accordance with an embodiment of the present subject matter.

[0028] Figure 13 is a schematic cross-sectional view of a laminate including a textured film in accordance with an embodiment of the present subject matter.

[0029] Figures 14A and 14B illustrate the aluminum test panel and test procedure used in Corrugation Conformability Test 1.

DETAILED DESCRIPTION

[0030] The present subject matter provides various textured films and methods and systems for their manufacture. In addition, the subject matter provides laminates utilizing the textured films. These aspects and accompanying details are as follows.

Films

[0031] In many embodiments, the films of the present subject matter are formed by depositing a flowable polymeric casting composition as described herein to form a layer or other region, and solidifying the composition to thereby form the films as described herein.

[0032] In many embodiments, the films of the present subject matter define an outer textured face. However, the present subject matter also includes films having both faces textured. Moreover, the present subject matter includes films having only portion(s) of one or both faces textured.

[0033] In some embodiments, the textured films described herein can have an average thickness of at least 50 microns (e.g., at least 75 microns, at least 100 microns, at least 125 microns, at least 150 microns, at least 175 microns, at least 200 microns, or at least 225 microns). In some embodiments, the textured films described herein can have an average thickness of 250 microns or less (e.g., 225 microns or less, 200 microns or less, 175 microns or less, 150 microns or less, 125 microns or less, 100 microns or less, or 75 microns or less.

[0034] The textured films described herein can have an average thickness ranging from any of the minimum values described above to any of the maximum values described above. For example, in some embodiments, the textured films described herein can have an average thickness of from 50 microns to 250 microns, from 50 microns to 200 microns, from 50 microns to 150 microns, from 50 microns to 100 microns, or from 100 microns to 150 microns. However, the present subject matter can include films having thicknesses less than 50 microns and/or thicknesses greater than 250 microns.

[0035] The films are formed using certain casting compositions as described herein. The casting composition generally comprises at least one polymeric resin. In many embodiments, the resin is selected from the group consisting of polyvinyl chloride resin(s), polyurethane resin(s), acrylic resin(s), and combinations thereof. However, the present subject matter includes other resin(s). In some embodiments in which the casting composition includes one or more polyvinyl chloride resin(s), the

casting composition can also comprises from 10 to 40 parts of plasticizer, per hundred parts of resin (phr), one or more heat stabilizer(s), one or more UV stabilizer(s), and optional pigments for coloring. For embodiments in which the casting composition includes one or more polyurethane(s) and/or acrylic resin(s), the casting composition can also comprise one or more extrusion aids, UV stabilizer(s), and optional pigments for coloring. The casting composition may include one or more other agents such as but not limited to coloring agent(s), processing agent(s), flow controlling additive(s), drying agent(s), and curing or crosslinking agent(s) as desired.

[0036] In certain embodiments, the polymeric composition can comprise a blowing agent (e.g., a heat-activated blowing agent) which generates the textured film. Suitable blowing agents are known in the art and include, for example, expandable microspheres that can be dispersed within the polymeric composition. Such microspheres can comprise a plastic coating surrounding an expandable liquid or gaseous volatile fluid. As is explained in U.S. Pat. No. 3,615,972 issued Oct. 26, 1971, to Morehouse et al., thermoplastic microspheres are adapted to expand dramatically when exposed to heat. These microspheres are monocellular particles comprising a body of resinous material encapsulating a volatile fluid. When heated, the resinous material of thermoplastic microspheres softens and the volatile material expands--causing the entire microsphere to increase substantially in size. On cooling, the resinous material in the shell of the microspheres ceases flowing and tends to retain its enlarged dimension; the volatile fluid inside the microsphere tends to condense, causing a reduced pressure in the microsphere.

[0037] Such thermoplastic microspheres are now commercially available from AkzoNobel under the trademark EXPANCEL®. These microspheres may be obtained in a variety of sizes and forms. Suitable microsphere can have an initial average diameter of 5 to 40 microns and/or an average expanded diameter of 20 to 150 microns. The microspheres can have an unexpanded true density of 1250-1300 kg/m^3 and/or an expanded density below 20 kg/m^3. Suitable microsphere can exhibit expansion temperatures of from 80°C to 190°C, such as from 80°C to 130°C. In some embodiments, the blowing agent can be present in the polymeric composition at an amount of from 1% to 10% by weight, based on the total weight of the polymeric composition.

[0038] In certain embodiments, a secondary composition is utilized in forming the textured films. Details regarding use and deposition of the secondary composition are described in association with the methods herein. The secondary composition comprises at least one binder material and at least one particulate material. A wide array of binder materials can be used, but in may versions the binder material is a polymeric resin. In certain embodiments the binder material is a urethane resin or a vinyl

resin. Combinations of these resins could be used. The present subject matter includes the use of other resins in the secondary composition. The particulate material can for example be particulates of polydimethyl siloxane (PDMS), soft polyurethanes, natural rubber, styrene butadiene rubber (SBR), nitrile rubber, or the like. The particulates could also be particulates of hard acrylic resin, hard urethane resin, silica, or other inorganic, amorphous, or crystalline materials. It is also contemplated that recycled materials in particulate form could be utilized such as for example ground tires or other rubber or rubber-based products. Combinations of these materials could be used. It will be understood that the present subject matter is not limited to any of these binder materials and/or particulate materials.

[0039] The shape of the particulate materials used in the secondary compositions is selected so as to produce the feature depth characteristics as described herein. In many versions, the particulates are spheroidal, near-spheroidal, cube shaped, near-cube shaped, pyramidal shaped, flake shaped, platelet shaped, fibrous or longitudinal in shape, regular in shape, or irregular in shape. Combinations of different shaped particulates can be used.

[0040] The size of the particulate materials used in the secondary compositions is selected so as to produce the feature depth characteristics as described herein. In many embodiments, the particulates exhibit equivalent diameters within a range of from 12 to 1,000 microns, and more particularly from 12 to 50 microns. However, it will be appreciated that the present subject matter includes the use of particulates exhibiting equivalent diameters less than 12 microns, and/or greater than 1,000 microns. The term "equivalent diameter" as used herein refers to the maximum length of a line bisecting the particulate.

[0041] The secondary compositions may also comprise additional components such as but not limited to coloring agent(s), processing agent(s), flow controlling additive(s), drying agent(s), and curing or crosslinking agent(s) as desired.

[0042] In certain processes described herein, particulate materials separate from the noted secondary materials may be incorporated into the films to form or contribute to the textured faces as described. In these processes, the particulates can be those as described with regard to the secondary compositions.

Methods

[0043] The methods of the present subject matter involve forming textured face(s) on polymeric films. In certain versions, the methods involve forming polymeric films having one or more

textured faces that are produced in situ during film formation. In other versions, the methods involve forming textured face(s) on films after formation of the film.

[0044] In many embodiments, a textured film is formed using a substrate or surface that exhibits a surface configuration that is the opposite or negative of the desired surface configuration of the face(s) of the film. In many embodiments, the substrate or surface is a planar surface upon which is cast or otherwise deposited, a flowable composition and particularly, the flowable casting composition as described herein. In certain embodiments, the substrate or surface is in the form of an embossed member or roller or other force applying component which imparts a textured face to the film.

[0045] In still other embodiments, a textured face of the film is formed by using particular compositions which may for example comprise particulates such that upon deposition of the composition followed by solidification and/or additional operations, a film is formed having a textured face as described herein.

[0046] In still other embodiments, the polymeric material can comprise a blowing agent. The polymeric composition can be cast or otherwise deposited as a flowable composition on a substrate or surface. The blowing agent (e.g., expandable microcapsules) can then be activated (e.g., by heating), generating a textured face of the film.

[0047] Details regarding these methods are described herein with regard to various representative embodiments.

Laminates

[0048] The present subject matter also relates to laminates or articles that include the textured films described herein. In many embodiments, the laminates include a textured film and one or more adhesive(s) disposed along a face of the film which is opposite from the textured face. For example, the film may include an outer face that is textured and an inner face which has a layer or region(s) of adhesive on the inner face. Typically, such laminates also include a release liner or liner assembly covering the otherwise exposed face of the adhesive. Prior to use, i.e., application of the adhesive backed film to a surface of interest, the liner is removed to expose the adhesive face.

[0049] A wide range of adhesives may be used in conjunction with the textured films. Generally, the adhesive is a pressure sensitive adhesive (PSA) and is selected or tailored depending upon the intended use of the film or laminate. For applications in which the textured film is used as a vehicle wrapping film, a useful pressure sensitive adhesive is one exhibiting semi-permanence, i.e., long term removability.

[0050] A wide array of adhesives can be used. In many versions of the present subject matter, the adhesive is a clear, acrylic, permanent or semi-permanent adhesive. An example of such as adhesive which is commercially available is Loctite Duro-Tak 5815 available from Henkel.

[0051] In many versions of the present subject matter, upon incorporation in the laminate, the adhesive layer exhibits long term removability (LTR). As noted, this characteristic refers to the film being removable from a vehicle surface to which the film was previously applied for a time period of at least three (3) months. The present subject matter also includes films that do not exhibit this LTR characteristic. If the LTR characteristic is not necessary for the subject film, other adhesives can be used. Nonlimiting examples of such other adhesives include Duro-Tak 80-132A available from Henkel. In particular versions of the present subject matter, if the LTR characteristic is not necessary for the subject film, a wide array of solvent and nonsolvent acrylic adhesives could potentially be used.

[0052] The adhesive layer can have a thickness of from about 0.2 mil to about 2.0 mil, more particularly from about 1.25 mil to about 1.6 mil, and in many embodiments a thickness of about 1.4 mil.

[0053] A description of useful pressure sensitive adhesives may be found in Encyclopedia of Polymer Science and Engineering, Vol. 13, Wiley-Interscience Publishers (New York, 1988). Additional description of useful pressure sensitive adhesives may be found in Polymer Science and Technology, Vol. 1, Interscience Publishers (New York, 1964). Conventional pressure sensitive adhesives, including acrylic-based pressure sensitive adhesive s, rubber-based pressure sensitive adhesives and silicone-based pressure sensitive adhesive s are useful. The pressure sensitive adhesive may be a solvent based or may be a water-based adhesive. In one embodiment, the pressure sensitive adhesive comprises an acrylic emulsion adhesive.

[0054] In one embodiment, the adhesive may be formed from an acrylic based polymer. It is contemplated that any acrylic based polymer capable of forming an adhesive layer with sufficient tack to adhere to a substrate may function in the present subject matter. In certain embodiments, the acrylic polymers for the pressure sensitive adhesive layers include those formed from polymerization of at least one alkyl acrylate monomer containing from about 4 to about 12 carbon atoms in the alkyl group, and present in an amount from about 35-95% by weight of the polymer or copolymer. Such adhesives are described in U.S. Pat. No. 5,264,532, which is incorporated herein by reference in its entirety. Optionally, the acrylic based pressure sensitive adhesive might be formed from a single polymeric species.

[0055] The glass transition temperature of a pressure sensitive adhesive layer comprising acrylic polymers can be varied by adjusting the amount of polar, or “hard monomers”, in the copolymer, as described in U.S. Pat. No. 5,264,532, incorporated herein by reference. The greater the percentage by

weight of hard monomers is an acrylic copolymer, the higher the glass transition temperature. Hard monomers contemplated useful for the present invention include vinyl esters, carboxylic acids, and methacrylates, in concentrations by weight ranging from about zero to about thirty-five percent by weight of the polymer.

[0056] The pressure sensitive adhesive can be acrylic based such as those taught in U.S. Pat. No. 5,164,444 (acrylic emulsion), U.S. Pat. No. 5,623,011 (tackified acrylic emulsion) and U.S. Pat. No. 6,306,982. The adhesive can also be rubber-based such as those taught in U.S. Pat. No. 5,705,551 (rubber hot melt). It can also be radiation curable mixture of monomers with initiators and other ingredients such as those taught in U.S. Pat. No. 5,232,958 (UV cured acrylic) and U.S. Pat. No. 5,232,958 (EB cured). The disclosures of these patents as they relate to acrylic adhesives are hereby incorporated by reference.

[0057] Another useful acrylic pressure sensitive adhesive comprises a blend of emulsion polymer particles with dispersion tackifier particles as generally described in Example 2 of U.S. Pat. No. 6,306,982. The polymer is made by emulsion polymerization of 2-ethylhexyl acrylate, vinyl acetate, dioctyl maleate, and acrylic and methacrylic comonomers as described in U.S. Pat. No. 5,164,444 resulting in the latex particle size of about 0.2 microns in weight average diameters and a gel content of about 60%. In one embodiment, the adhesive is an acrylic adhesive commercially available as AE3349 from Avery Dennison.

[0058] In addition to the tackifiers, other additives may be included in the pressure sensitive adhesives to impart desired properties. For example, plasticizers may be included, and they are known to decrease the glass transition temperature of an adhesive composition comprising elastomeric polymers. Antioxidants also may be included on the adhesive compositions. Cutting agents such as waxes and surfactants also may be included in the adhesives. Light stabilizers, heat stabilizers, and UV absorbers also may be included in the adhesive compositions. Ultraviolet absorbers include benzo-triazol derivatives, hydroxy benzyl phenones, esters of benzoic acids, oxalic acid, diamides, etc. Light stabilizers include hindered amine light stabilizers, and the heat stabilizers include dithiocarbamate compositions such as zinc dibutyl dithiocarbamate.

[0059] The adhesive layer may be a single layer or comprise multiple layers of adhesive. The multiple layers of adhesive may be applied to any of the layer(s) described herein using methods known in the art. The present subject matter also includes adhesive layer(s) that are patterned as known in the art.

[0060] The laminates of the present subject matter can include one or more additional layers. Nonlimiting examples of such additional layers include one or more tie coat layer(s), one or more

white layer(s), one or more color layer(s), one or more clear layer(s), one or more print layer(s), one or more reflective layer(s), and combinations thereof.

[0061] A variety of tie coat materials can be used. In many versions of the present subject matter, the tie coat material is pigmented, and may be pigmented to exhibit particular colors such as gray or white. The present subject matter includes the use of pigments to produce other colors. An example of a gray tie coat material which can be used and which is commercially available is APV A-8892 available from APV Engineered Coatings. An example of a white tie coat material which can be used and which is commercially available is APV A-1060 available from APV Engineered Coatings.

[0062] The tie coat layer can have a thickness of from about 0.1 mil to about 1.4 mil, and more particularly from about 0.2 mil to about 1.0 mil. In certain embodiments, the tie coat thickness is from about 0.16 mil to about 0.26 mil and more particularly about 0.2 mil. And in other particular embodiments, the tie coat thickness is from about 0.75 mil to about 0.95 mil, and more particularly about 0.8 mil.

[0063] In applying a liquid tie coat material onto an immediately adjacent white or color layer, the tie coat can be applied at a coat weight in a range of from about 3 gsm to about 30 gsm, particularly 5 gsm to 21 gsm, and in certain embodiments 5 gsm or 21 gsm.

[0064] Additional details as to the tie coat layer(s) and their processing are provided in U.S. Pat. Nos. 6,042,678; 6,630,049; 7,060,351; 6,336,988; 6,547,912; and 6,106,982, each of which is hereby incorporated by reference in its entirety.

[0065] The white layer comprises a flexible synthetic resinous coating composition containing a sufficient amount of uniformly dispersed pigment to provide a white color in the overall appearance of the laminate. The white layer(s) used in the multilayer films are typically white vinyl materials.

[0066] The thickness of the white layer is typically from about 1.0 mil to about 2 mil, particularly from about 1.2 mil to about 1.8 mil, more particularly from about 1.4 mil to about 1.6 mil, and in certain embodiments about 1.5 mil.

[0067] Additional details as to the white layer(s) and their processing are provided in U.S. Pat. Nos. 6,042,678; 6,630,049; 7,060,351; 6,733,870; 6,547,912; and 6,171,681, each of which is hereby incorporated by reference in its entirety.

[0068] The color layer comprises a flexible synthetic resinous coating composition containing a sufficient amount of uniformly dispersed pigment to provide the appearance necessary for exterior vehicle use. The resinous material contained in the color layer functions in combination with other layer(s)

in the laminates to produce the required exterior film surface characteristics. The color layer(s) used in the laminates are typically colored vinyl materials.

[0069] The color layer and/or the previously noted white layer may contain a substantial pigment level in order to provide sufficient opacity to maintain desirable coloration. For most colors, a pigment level from about 2% to about 30%, by weight of the solids contained in the layer produces the desired opacity in the finished laminate. The amount of pigment used varies depending upon the color. For a white color coat used over a vehicle body panel, for example, a pigment level of about 30%, by weight of the total solids, can be used. For a black color coat using carbon black pigment applied over a vehicle body panel, about 2% pigment can be used, for example.

[0070] The pigment contained in the color layer and/or the white layer can affect exterior vehicle properties. For instance, different pigments, even of the same color, can vary widely with respect to their resistance to weathering, particularly UV weatherability. The pigments dispersed in the color layer and/or the white layer may retain plasticizer(s) and, thereby, may prevent plasticizer migration which can cause intercoat adhesion and volatile haze problems. A high pigment level in the color layer and/or the white layer also can affect mechanical properties of the coating, such as durability and elongation.

[0071] Thus, the desired color layer and/or the white layer formulation provides the appearance and durability properties which, in combination with other layer(s) such as the clear layer, produce a laminate having the properties suitable for exterior vehicle use.

[0072] The thickness of the color layer is typically from about 1.0 mil to about 2.5 mil, more particularly from about 1.2 mil to about 2.2 mil, and in certain embodiments from about 1.4 mil to about 1.6 mil and more particularly about 1.5 mil, and in other embodiments from about 1.8 mil to about 2.2 mil and more particularly about 2.0 mil.

[0073] Additional details as to the color layer(s) and their processing are provided in U.S. Pat. Nos. 6,042,678; 6,630,049; 7,060,351; 6,733,870; 6,547,912; and 6,171,681, each of which is hereby incorporated by reference in its entirety.

[0074] The clear layer is a transparent or substantially transparent thermoplastic synthetic resinous coating composition coated in thin film form. The clear layer typically constitutes an outermost layer or surface of the film and/or laminate after application to a surface of interest such as a vehicle surface. The clear layer(s) used in the laminates are generally clear vinyl materials. The resinous material contained in the clear layer functions in combination with other layer(s) in the film to produce the required exterior film surface characteristics.

[0075] The thickness of the clear layer can be from about 0.2 mil to about 1.5 mil, more particularly from about 1.0 mil to about 1.4 mil, more particularly about 1.1 mil to about 1.3 mil, and in certain embodiments about 1.2 mil.

[0076] Additional details as to the clear layer(s) and their processing are provided in U.S. Pat. Nos. 6,296,732; 6,773,804; 6,042,678; 6,630,049; and 7,060,351, each of which is hereby incorporated by reference in its entirety.

[0077] The laminates of the present subject matter can also include one or more layers in addition to various combinations of the noted layers. Nonlimiting examples of additional layers include top or topcoat layers, which would typically be clear. Multiple color layers could also be used. One or more supplemental opacifying layers could also be incorporated in the laminates. In addition, one or more release layers can be included such as layers of silicone and particularly polydimethylsiloxane release agents known in the art. Liner layers, liner assemblies, and carrier films or agents can also be incorporated in the laminates of the present subject matter.

[0078] The laminates can have a total thickness of from about 2 mil to about 8 mil, more particularly from about 2 mil to about 8 mil, more particularly from about 4 mil to about 7 mil, and in certain versions from about 3 mil to about 6 mil or from about 5 mil to about 6 mil. The present subject matter includes laminates as described herein having a total thickness of less than 3 mil, and a total thickness greater than 8 mil.

[0079] The release liners that may be utilized in the laminates of the present subject matter can include any of a variety of materials. In one embodiment, the release liner comprises a 90# stayflat liner. Other suitable release liners include silicone coated films or polycoated kraft, as are known in the art. Suitable pre-siliconized release liners are available commercially.

[0080] The laminates of the present subject matter can be stored and/or provided in a variety of forms. Typically, the laminates are provided in a sheet form or a roll form.

Applications

[0081] The films and laminates of the present subject matter can be used in a wide array of applications. A particular application is for adhering the textured film to vehicle body panels or other vehicle members or components. The textured films can also be used for interior applications in vehicles. However, the present subject matter includes uses as interior and/or exterior layers for building or architectural components, walkways, and the like where a high friction or non-slip surface is desired. The films and laminates may also be used as signage, graphic displays, exterior displays, decorative

applications, and the like. The present subject matter is not limited to any of these applications and includes a range of other uses.

Representative Embodiments

[0082] Referring to Figure 1, a schematic illustration of a system 100 in accordance with the present subject matter is depicted. The system 100 comprises a casting assembly 105 typically including a textured casting sheet, belt, or other substrate 110 upon which a flowable polymeric casting composition 120 is deposited. The casting composition can be as described herein. The casting sheet 110 defines a textured face described in greater detail herein. In the system 100 depicted in Figure 1, the casting sheet 110 is in the form of a continuous belt extending between drums 130 and 135. However, it will be understood that the present subject matter includes the use of other casting assemblies besides 105, such as drum casting machines and casting lines using support films. Additional details and aspects of casting equipment and components are provided in "Solvent Cast Technology – A Versatile Tool for Thin Film Production," Ulrich Siemann, Progr. Colloid Polymer Science, 130:1-14 (2005), which is incorporated by reference in its entirety.

[0083] The casting composition 120 is deposited onto a textured face on the casting sheet 110 to form a textured film 140. As will be understood, the flowable casting composition 120 adopts a negative surface configuration relative to the textured face of the casting sheet. Upon solidification of the casting composition 120, and removal of the resulting textured film 140 from the casting assembly 105, the film 140 can be collected on a wind-up roll or in an appropriate fashion as desired. The textured film 140 may also be subjected to one or more other processing operations.

[0084] As shown in Figure 2, the textured film 140 defines a textured outer face 145 and an oppositely directed inner face 148. As will be appreciated, the textured outer face 145 results from the textured face of the casting sheet 110. The outer face 145 exhibits particular characteristics as follows. The textured outer face 145 includes a plurality of projections 146 in which the dimensional height of these features, referred to herein as the "feature depth," is typically within a range of from 12 microns to 75 microns, as measured by atomic force microscopy (AFM). The feature depth may be as great as 150 microns if the total thickness of the film is greater than 150 microns. The feature depth is measured in a direction transverse to the plane of the film 140, which typically corresponds to the inner face 148. In particular versions of the film 140, the feature depth of the projections 146 along the outer face 145 is within a range from 12 to 50 microns, and more particularly from 12 to 25 microns. The feature depth is measured from a distal most region or tip of a projection 146 toward the inner face 148. In many versions,

at least 90%, at least 95%, and preferably at least 99% of the projections exhibit feature depths within these dimensional ranges.

[0085] In particular versions, the textured film 140 may also exhibit particular surface densities of the projections 146 along the outer face 145. The reference to "surface densities" of the projections 146, refers to the number of projections per unit area along the outer face 145. In the noted particular versions, the surface density of projections 146 typically is from 5 to 1,000 total projections per 1 cm^2 of the outer face 145 and more particularly from 10 to 100 total projections per 1 cm^2 of the outer face 145. The reference to "1 cm^2" herein is with regard to the outer face when viewed in a planar or direct-on fashion. That is, the reference to "1 cm^2" is not with regard to the actual surface area of the outer face. It will be understood that due to the typical number of projections and feature depths of such projections, the actual surface area within a 1 cm^2 region of the outer face will be significantly greater than 1 cm^2. It will further be appreciated that the films of the present subject matter are not limited to these representative surface densities and may include films having surface densities less than 5 total projections/cm^2 and/or greater than 1,000 total projections/cm^2.

[0086] As noted, in order to produce the noted textured film 140, the casting sheet 110 exhibits a similar textured surface, but is a "negative" of the outer face 145 of the film 140. Thus, the textured face of the casting sheet 110 includes a plurality of depressions or recesses in which the dimensional height (or depth) of these features is within a range of from 12 microns to 150 microns, typically from 12 microns to 75 microns, in certain versions from 12 to 50 microns, and more particularly from 12 to 25 microns. However, it will be understood that the subject matter includes casting sheets having depressions less than 12 microns and/or greater than 150 microns.

[0087] And, in particular versions the casting sheet 110 exhibits a surface density of depressions that results in the noted surface density of projections in the textured film 140. Thus, in such versions the casting sheet 110 exhibits a total number of depressions within a range of from 5 to 1,000 depressions per 1 cm^2, and in particular versions from 10 to 100 depressions per 1 cm^2 of the casting sheet. However, it will be appreciated that the subject matter includes casting sheets having surface densities of depressions less than 5 depressions per cm^2, and/or greater than 1,000 depressions per cm^2.

[0088] Referring to Figure 3, a schematic illustration of a system 200 in accordance with the present subject matter is depicted. The system 200 comprises a casting assembly 105 as previously described but including a smooth or substantially smooth face casting sheet, belt, or other substrate 210. A flowable polymeric casting composition such as previously described casting composition 120 is deposited upon the smooth face casting sheet 210.

[0089] Upon at least partial solidification of the casting composition 120, and removal of the resulting intermediate film 125 from the casting assembly 105 as depicted in Figures 3 and 4, the intermediate film 125 is directed to a heated embossing roll 150. The heated embossing roll 150 defines an outer generally circumferential textured face 155 that imparts a "negative" surface configuration onto a face of the intermediate film 125, to thereby produce the textured film 140 shown in Figure 5. The present subject matter includes other embossing members in addition to, or instead of the noted embossing roll 150. Such embossing members could be non-cylindrical or planar. The resulting textured face is shown as outer face 145 and includes a plurality of projections 146 as previously described in association with Figure 2.

[0090] In many versions of the textured film 140 produced using the system 200 and process shown in Figure 3, the outer face 145 of the film 140 exhibits one or both of the previously noted feature depth characteristics and/or the surface density characteristics.

[0091] In many versions, the circumferential textured outer face 155 of the heated embossing roll 150 includes a plurality of depressions in which at least 90%, at least 95%, and preferably at least 99% of the depressions exhibit a feature depth within a range of from 12 microns to 150 microns (if the film thickness is greater than 150 microns), typically from 12 microns to 75 microns, and particularly from 12 to 50 microns, or 12 to 25 microns. However, it will be appreciated that the subject matter includes embossing rolls with outer faces having depressions less than 12 microns and/or greater than 150 microns.

[0092] In particular versions, the circumferential textured outer face 155 of the heated embossing roll 150 exhibits a surface density of depressions that results in the noted surface density of projections in the textured film 140. Therefore, in such versions the outer face 155 exhibits a total number of depressions within a range of from 5 to 1,000 depressions per 1 cm^2, and in particular versions from 10 to 100 depressions per 1 cm^2 of the outer face 155. However, it will be understood that the subject matter includes embossing rolls having outer faces with surface densities less than 5 depressions per cm^2 and/or greater than 1,000 depressions per 1 cm^2.

[0093] The heated embossing roll 150 is typically heated to a temperature such that contact and pressure between the intermediate film 125 and the outer face 155 of the roll 150 for the time period occurring in producing the film 140, results in sufficient softening of the polymeric material of the film so that the surface configuration defined along the outer face 155 is imparted to the outer face of the intermediate film 125 to thereby produce the textured outer face 145 of the film 140. Representative nonlimiting examples of temperatures of the heated embossing roll are from about 65°C (150° F.) to about

205°C (400° F.). The present subject matter includes the use of temperatures less than 65°C and/or greater than 205°C.

[0094] Referring to Figure 6, a schematic illustration of a system 300 in accordance with the present subject matter is depicted. The system 300 comprises a casting assembly 105 as previously described but including a smooth or substantially smooth face casting sheet, belt, or other substrate 210. A flowable polymeric casting composition such as previously described casting composition 120 is deposited upon the smooth face casting sheet 210.

[0095] Upon at least partial solidification of the casting composition 120, and removal of the resulting intermediate film 125 from the casting assembly 105 as shown in Figures 6 and 7, the intermediate film 125 receives a secondary material 150 which is deposited on a face 127 of the intermediate film 125. The present subject matter also includes not fully solidifying the intermediate film 125. That is, the secondary material 150 could be deposited upon a face of a partially solidified intermediate film 125.

[0096] The secondary material 150 as previously described herein, comprises at least one binder material and at least one particulate material. The secondary material is deposited onto the intermediate film 125 to form a textured film 160 as depicted in Figure 8. As a result of the composition of the secondary material 150, the manner of deposition of the secondary material 150 onto the intermediate film 125, and/or subsequent processing of the deposited secondary material 150, a resulting outer face 155 of the textured film 160 includes a plurality of projections 156. The outer face 155 exhibits a surface configuration as previously described herein. That is, the projections 156 of the outer face 155 may exhibit the previously described feature depths and/or the previously described surface densities of the textured films 140 shown in Figures 2 and 5.

[0097] Referring to Figure 9, a schematic illustration of a system 400 in accordance with the present subject matter is depicted. The system 400 comprises a casting assembly 105 as previously described but including a smooth or substantially smooth casting sheet, belt, or other substrate 210. A flowable polymeric casting composition such as previously described casting composition 120 is deposited upon the smooth face casting sheet 210.

[0098] Upon at least partial solidification of the casting composition 120, and removal of the resulting intermediate film 125 from the casting assembly 105 as shown in Figures 9 and 10, the intermediate film 125 receives particulate material 165. In many versions of this process 400, the intermediate film 125 is heated such as by passing the intermediate film 125 alongside a heater 410 to heat a face 127 of the intermediate film 125 prior to deposition of particulate material 165. After optional

heating, the particulate material 165 is deposited onto the face 127 of the intermediate film 125 and then directed to nip roller(s) 420 which apply pressure to the particulates 165 and at least partially embed the particulates 165 into the face 127 of the intermediate film 125 as depicted in Figure 11, to form a modified intermediate film 170. In certain versions of the process 400, the nip roller(s) 420 can be heated to soften the polymeric material of the film 125 and promote embedding of particulates 165 into the film 125, and specifically into the face 127 of the film 125. If the nip roller(s) 420 are heated, it may not be necessary or beneficial to utilize the heater 410.

[0099] After forming the modified intermediate film 170, a flowable coating composition 180 is then deposited over the particulates 165 and the outer face 127 of the film 170. In many embodiments, a portion of surface area of the particulates 165 is exposed above the outer face 127, and is completely covered by the coating composition 180. However, the present subject matter includes embodiments in which portions of the particulates 165 remain uncovered by the coating composition 180. The coating composition 180 can in certain embodiments be the same or similar composition as the casting composition 120. However, the present subject matter includes processes and films in which the coating composition 180 is compositionally different than the casting composition 120. Upon solidification of the casting composition 180, a textured film 190 is formed, as schematically depicted in Figure 12. The textured film 190 defines a textured outer face 195 as described herein having a plurality of projections 196 with the characteristics described herein. That is, the resulting outer face 195 of the film 190 exhibits the same or similar feature depths and/or surface densities as described herein in association with the films 140 of Figures 2 and 5.

[0100] In all of the processes described herein, it will be appreciated that upon depositing the casting composition 120 upon a receiving surface, e.g., the casting sheet 110 or substrate 210, such deposition can be performed by multiple passes or multiple coats of the composition 120. Such techniques may avoid or reduce the potential for forming voids and/or other defects in the resulting film.

[0101] In the processes depicted in Figures 3, 6, and 9, it will be understood that the face of the casting sheet 210 is typically smooth and need not exhibit a surface configuration that results in forming a textured film. This is because the textured face of the film is formed after formation of the film. However, the present subject matter also includes processes in which the face of the casting sheet 210 includes a surface configuration that results at least partially, or partially produces, the textured face of the textured film. Such processes may utilize a multistep strategy in forming the textured films in which after initial texturing occurs by use of the noted casting sheet 210, additional texturing occurs by (i) using heated embossing roll(s) as shown in Figure 3, (ii) using secondary composition(s) as depicted in Figure 6,

(iii) using particulates and coating composition(s) as in Figure 9, and/or employing one or more, or combinations of these aspects.

[0102] Figure 13 schematically illustrates an embodiment of a laminate 500 in accordance with the present subject matter. The laminate 500 comprises a textured film which for example may be previously described textured films 140, 160, or 190. The laminate 500 also comprises a layer or region of adhesive 510. The laminate 500 may optionally comprise a release liner 520 generally covering the adhesive 510. Details of each of these layers and/or components are described herein. It will be understood that the present subject matter includes a wide array of laminates and is not limited to the representative laminate 500 depicted in Figure 13.

[0103] In certain embodiments, the laminates described herein can exhibit 3-dimensional conformability. The 3-dimensional conformability of the laminates described herein can be evaluated using Corrugation Conformability Test 1. This standard test method generally evaluates the conformability and adhesion of a laminate to a painted aluminum test panel which includes a corrugation channel.

[0104] Briefly, a 4" X 12" painted aluminum test panel including a corrugation channel having a width of approximately 1.25" and a depth of approximately 0.33" was cleaned with heptane first, followed by isopropyl alcohol, to remove dirt, oil, and other contaminants. A top and side view of the test panel (with sample strips applied and lifted following aging) are shown in Figures 14A and 14B respectively.

[0105] Two laminate sample strips (1'' wide by at least 8'' long) were cut with a rotary die cutter, cutting die, or die press. The two sample strips were then applied across the corrugation using the standard methods described in "Application Avery Dennison SuperCast Films on Irregular Substrates" Avery Dennison Instruction Bulletin #4.07 (Revision 2), dated January 16, 2017. Briefly, the sample strips were applied over the corrugation channel by tacking each sample strip down at the top of the panel and bridging the corrugation with the sample strip. The sample strip was pressed down at upper edges of corrugation. Next, the fingertips of a white cotton glove were wetted with a water/soap mixture. The sample strips were then heated to a target temperature of from 40–50°C (105–120°F) using a hot air gun. The surface temperature was monitored using a Surface Temperature Thermometer/ IR Thermometer. Using the moist glove, the sample strips were first pressed into deepest part of corrugation while maintaining sample target temperature. The sample strips were then pressed into the opposite bend of the corrugation, again while maintaining sample preheat temperature. Finally, the sample strips were pressed into the center of the corrugation, working from one edge to the other to allow air to escape. If

air bubbles persisted, they were removed by heating lightly and puncturing with a pin. The remaining air was then pushed out. The sample strips and underlying panel were then heated to a setting temperature of from 80–90°C (175–194°F). Following setting, the sample strips were allowed to dwell 24 hours after application to build functional bond.

[0106] After dwelling, sample strip lift was assessed in both the machine direction (along panel) and in the cross direction (cross panel). See Figures 14A-14B for diagram of panel with applied sample strips and definition of measurements. 8.13 The sample were then aged for 1000 hours in a QUV chamber (8 hours UV exposure at 70°C followed by 4 hours of condensation at 50°C). Lift was assessed in both the machine direction (along panel) and in the cross direction (cross panel) every 250 hours. If lift was observed in the machine direction or the cross direction, the sample was judged to not to exhibit 3-dimensional conformability. If no lift was observed in the machine direction or the cross direction, the sample was judged to exhibit 3-dimensional conformability.

[0107] Many other benefits will no doubt become apparent from future application and development of this technology.

[0108] All patents, applications, standards, and articles noted herein are hereby incorporated by reference in their entirety.

[0109] The present subject matter includes all operable combinations of features and aspects described herein. Thus, for example if one feature is described in association with an embodiment and another feature is described in association with another embodiment, it will be understood that the present subject matter includes embodiments having a combination of these features.

[0110] As described hereinabove, the present subject matter solves many problems associated with previous strategies, systems and/or devices. However, it will be appreciated that various changes in the details, materials and arrangements of components, which have been herein described and illustrated in order to explain the nature of the present subject matter, may be made by those skilled in the art without departing from the principle and scope of the claimed subject matter, as expressed in the appended claims.

WHAT IS CLAIMED IS:

1. A textured polymeric film defining a textured outer face and an oppositely directed inner face, the outer face including a plurality of projections, wherein at least 90% of the projections exhibit a feature depth of from 12 microns to 150 microns, as measured by atomic force microscopy (AFM).

2. The textured film of claim 1 wherein at least 90% of the projections exhibit a feature depth of from 12 microns to 75 microns, from 12 microns to 50 microns, or from 12 microns to 25 microns, as measured by AFM.

3. The textured film of any of claims 1-2, wherein the outer face exhibits a surface density of projections of from 5 to 1,000 projections per 1 cm^2, or from 10 to 100 projections per 1 cm^2.

4. The textured film of any of claims 1-3, wherein the film comprises a resin selected from the group consisting of polyvinyl chloride resin, polyurethane resin, acrylic resin, and combinations thereof.

5. The textured film of claim 4, wherein the film comprises polyvinyl chloride resin, and wherein the film further comprises from 10 to 40 parts of a plasticizer per hundred parts of polyvinyl chloride resin.

6. The textured film of any of claims 1-5, wherein the film exhibits an average thickness of 250 microns or less, such as from 50 microns to 250 microns, from 50 microns to 200 microns, from 50 microns to 150 microns, from 50 microns to 100 microns, or from 100 microns to 150 microns.

7. A process for producing a textured polymeric film, the process comprising:

providing a textured casting sheet having an outer surface including a plurality of depressions, wherein at least 90% of the depressions exhibit a feature depth of from 12 microns to 150 microns, as measured by AFM;

depositing a flowable polymeric composition onto the outer surface of the casting sheet to form a layer thereon;

solidifying the layer of the polymeric composition to thereby form a textured polymeric film.

8. The process of claim 7, further comprising:

removing the textured polymeric film from the casting sheet; and

collecting the textured polymeric film in a roll.

9. A process for producing a textured polymeric film, the process comprising:

providing a casting sheet having an outer surface;

depositing a flowable polymeric composition onto the outer surface of the casting sheet to form a layer thereon;

at least partially solidifying the layer of the polymeric composition to thereby form an intermediate film;

providing a heated embossing roll defining a circumferential textured outer face including a plurality of depressions, wherein at least 90% of the depressions exhibit a feature depth of from 12 microns to 150 microns, as determined by AFM;

contacting the intermediate film with the heated embossing roll to thereby form a textured polymeric film.

10. The process of claim 9, further comprising:

removing the textured polymeric film from the embossing roll; and

collecting the textured polymeric film in a roll.

11. The process of any of claims 9-10, wherein the heated embossing roll is at a temperature of from 65°C to 205°C.

12. A process for producing a textured polymeric film, the process comprising:

providing a casting sheet having an outer surface;

depositing a flowable polymeric composition onto the outer surface of the casting sheet to form a layer thereon;

at least partially solidifying the layer of the polymeric composition to thereby form an intermediate film;

depositing a secondary material onto an outer surface of the intermediate film to thereby form a textured polymeric film,

wherein an outer face of the textured polymeric film includes a plurality of projections, at least 90% of the projections exhibit a feature depth of from 12 microns to 150 microns, as determined by AFM.

13. The process of claim 12, further comprising:

removing the textured polymeric film; and

collecting the textured polymeric film in a roll.

14. The process of any of claims 12-13, wherein the secondary material comprises at least one binder material and at least one particulate material.

15. The process of claim 14, wherein the binder material is selected from the group consisting of urethane resin, vinyl resin, and combinations thereof.

16. The process of any of claims 14-15, wherein the particulate material includes particulates selected from the group consisting of polydimethyl siloxane, polyurethane, natural rubber, styrene butadiene rubber, nitrile rubber, acrylic resin, silica, and combinations thereof.

17. The process of any of claims 14-16, wherein the particulate material includes particulates exhibiting an equivalent diameter of from 12 microns to 1,000 microns, such as from 12 microns to 50 microns.

18. A process for producing a textured polymeric film, the process comprising:

providing a casting sheet having an outer surface;

depositing a flowable polymeric composition onto the outer surface of the casting sheet to form a layer thereon;

at least partially solidifying the layer of the polymeric composition to thereby form an intermediate film;

depositing particulate material onto an outer face of the intermediate film;

at least partially embedding at least a portion of the particulate material into the outer face of the intermediate film to thereby form a modified intermediate film;

depositing a coating material onto the particulate material and the outer face of the modified intermediate film;

solidifying the coating material deposited on the particulate material and the outer face of the modified intermediate film to thereby form a textured polymeric film,

wherein the deposited coating material constitutes a textured outer face of the textured polymeric film, the textured outer face including a plurality of projections, wherein at least 90% of the projections exhibit a feature depth of from 12 microns to 150 microns, as determined by AFM.

19. The process of claim 18, further comprising:

removing the textured polymeric film; and

collecting the textured polymeric film in a roll.

20. The process of any of claims 18-19, wherein the particulate material includes particulates selected from the group consisting of polydimethyl siloxane, polyurethane, natural rubber, styrene butadiene rubber, nitrile rubber, acrylic resin, silica, and combinations thereof.

21. The process of any of claims 18-20, wherein the particulate material includes particulates exhibiting an equivalent diameter of from 12 microns to 1,000 microns, such as from 12 microns to 50 microns.

22. A process for producing a textured polymeric film, the process comprising:

providing a casting sheet having an outer surface;

depositing a flowable polymeric composition comprising a blowing agent onto the outer surface of the casting sheet to form a layer thereon;

at least partially solidifying the layer of the polymeric composition to thereby form an intermediate film; and

heating the intermediate film to activate the blowing agent, thereby forming a textured polymeric film defining a textured outer face and an oppositely directed inner face, the outer face including a plurality of projections, wherein at least 90% of the projections exhibit a feature depth of from 12 microns to 150 microns, as measured by atomic force microscopy (AFM).

23. The process of claim 22, further comprising:

removing the textured polymeric film; and

collecting the textured polymeric film in a roll.

24. The process of any of claims 22-23, wherein the blowing agent comprises expandable microspheres.

25. The process of claim 24, wherein the expandable microspheres have an average particle size of from 5-40 microns.

26. The process of any of claims 24-25, wherein upon heating, the expandable microspheres exhibit an average expanded particle size of from 20 to 150 microns.

27. The process of any of claims 22-26, wherein the blowing agent is present in the polymeric composition at an amount of from 1% to 10% by weight, based on the total weight of the polymeric composition.

28. The process of any of claims 22-27, wherein heating the intermediate film to activate the blowing agent comprises heating the intermediate film to a temperature of from 80°C to 190°C, such as from 80°C to 130°C.

29. The process of any of claims 7-28, wherein at least 90% of the depressions exhibit a feature depth within a range of from 12 microns to 75 microns, from 12 microns to 50 microns, or from 12 microns to 25 microns, as measured by AFM.

30. The process of any of claims 7-29, wherein the outer surface of the casting sheet exhibits a surface density of depressions within a range of from 5 to 1,000 depressions per 1 cm^2, or from 10 to 100 depressions per 1 cm^2.

31. The process of any of claims 7-30, wherein the polymeric composition comprises a resin selected from the group consisting of polyvinyl chloride resin, polyurethane resin, acrylic resin, and combinations thereof.

32. A textured film produced by the process of any of claims 7-31.

33. A laminate comprising:

a textured polymeric film defining by any of claims 1-6; and

adhesive disposed on the inner face of the film.

34. The laminate of claim 33, further comprising a release liner at least partially covering the adhesive.

35. The laminate of any of claims 33-34, wherein the laminate is in roll form.

36. The laminate of any of claims 33-35, wherein the laminate exhibits 3-dimensional conformability, as determined using Corrugation Conformability Test 1.

37. The laminate of any of claims 33-36, wherein the laminate has a thickness of from 2 mil to 8 mil, such as from 3 mil to 6 mil.

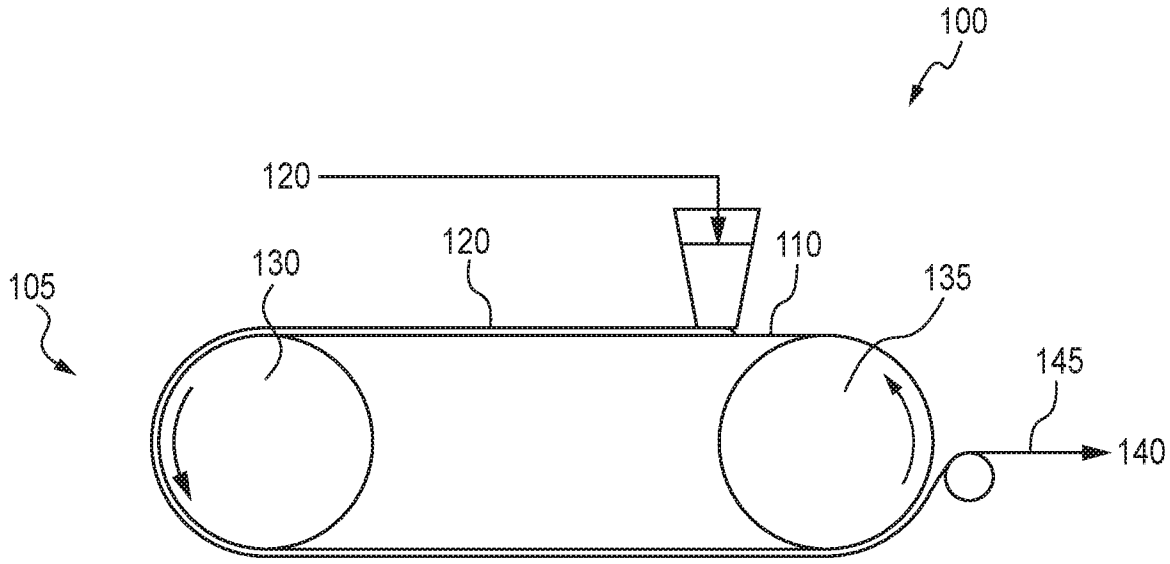

FIG. 1

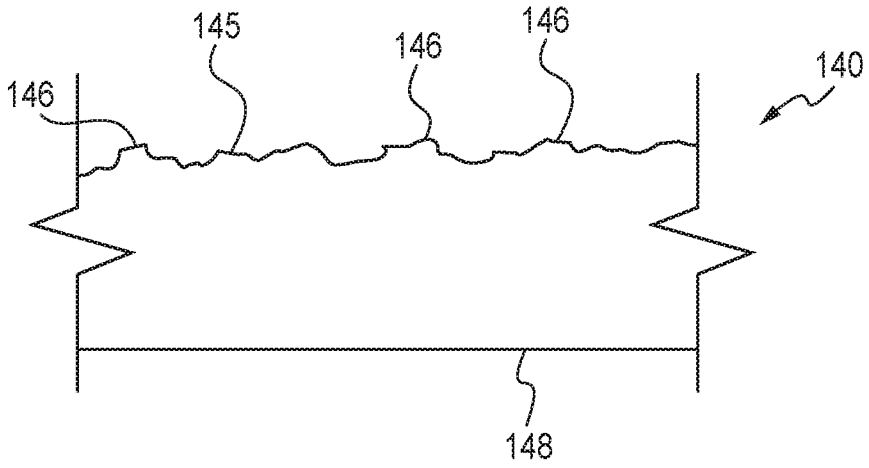

FIG. 2

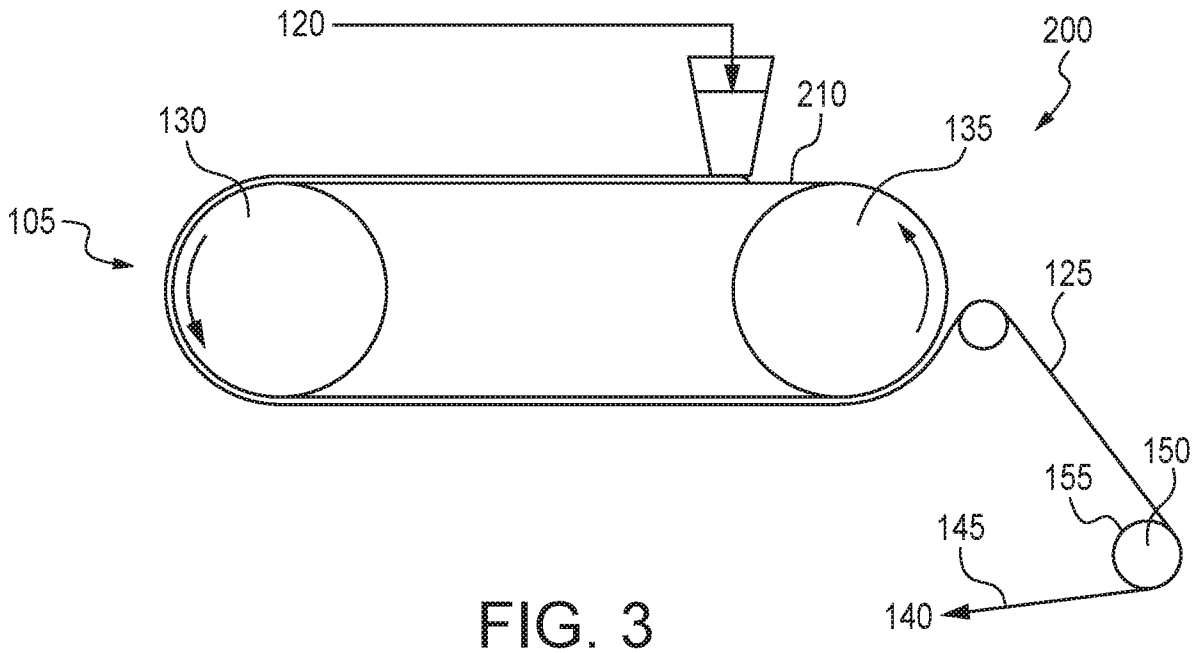

FIG. 3

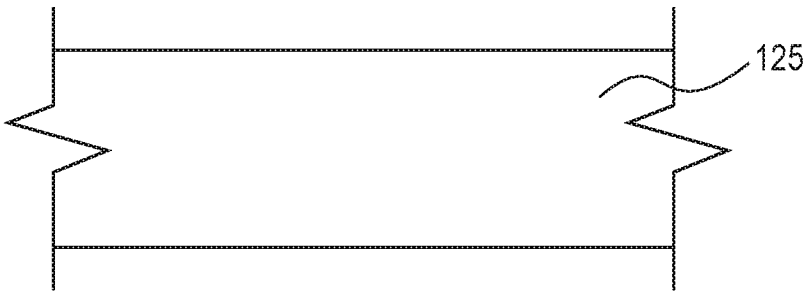

FIG. 4

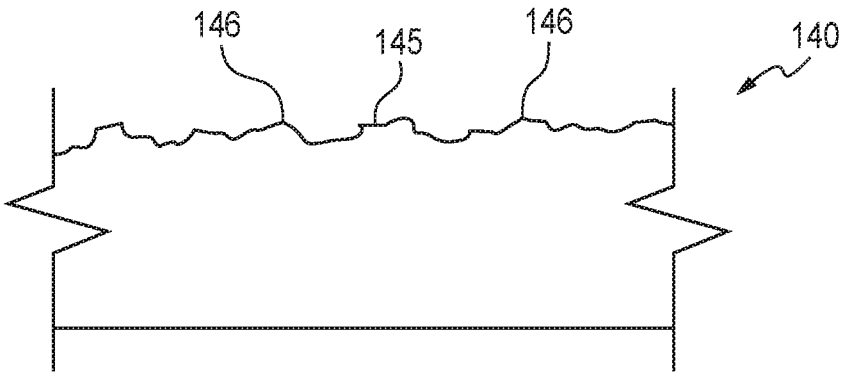

FIG. 5

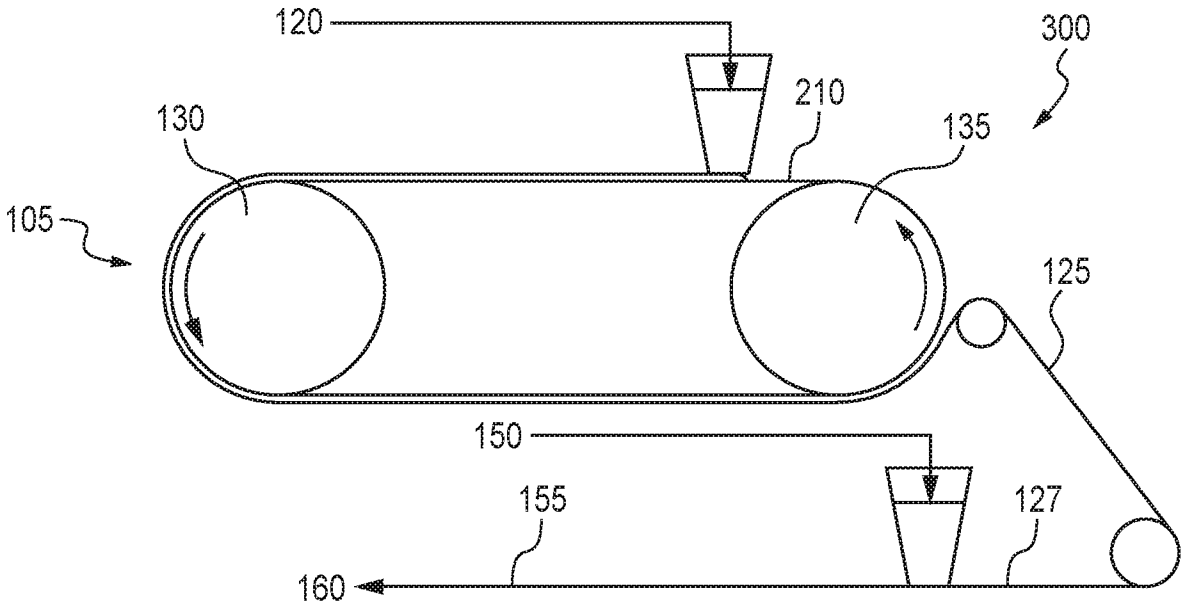

FIG. 6

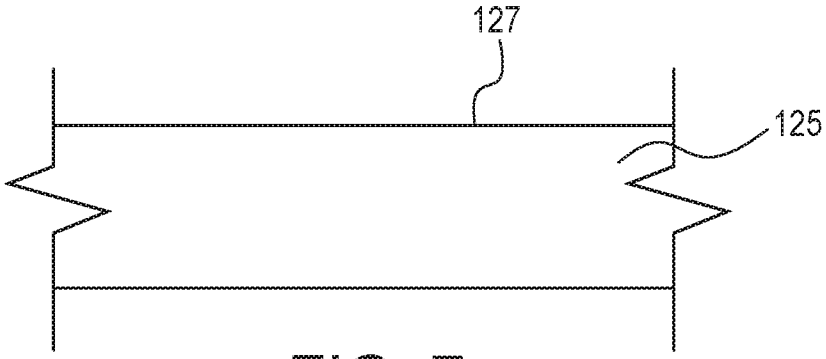

FIG. 7

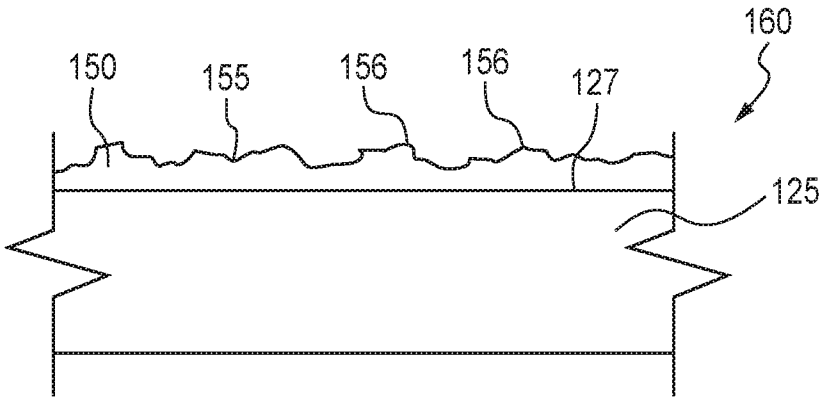

FIG. 8

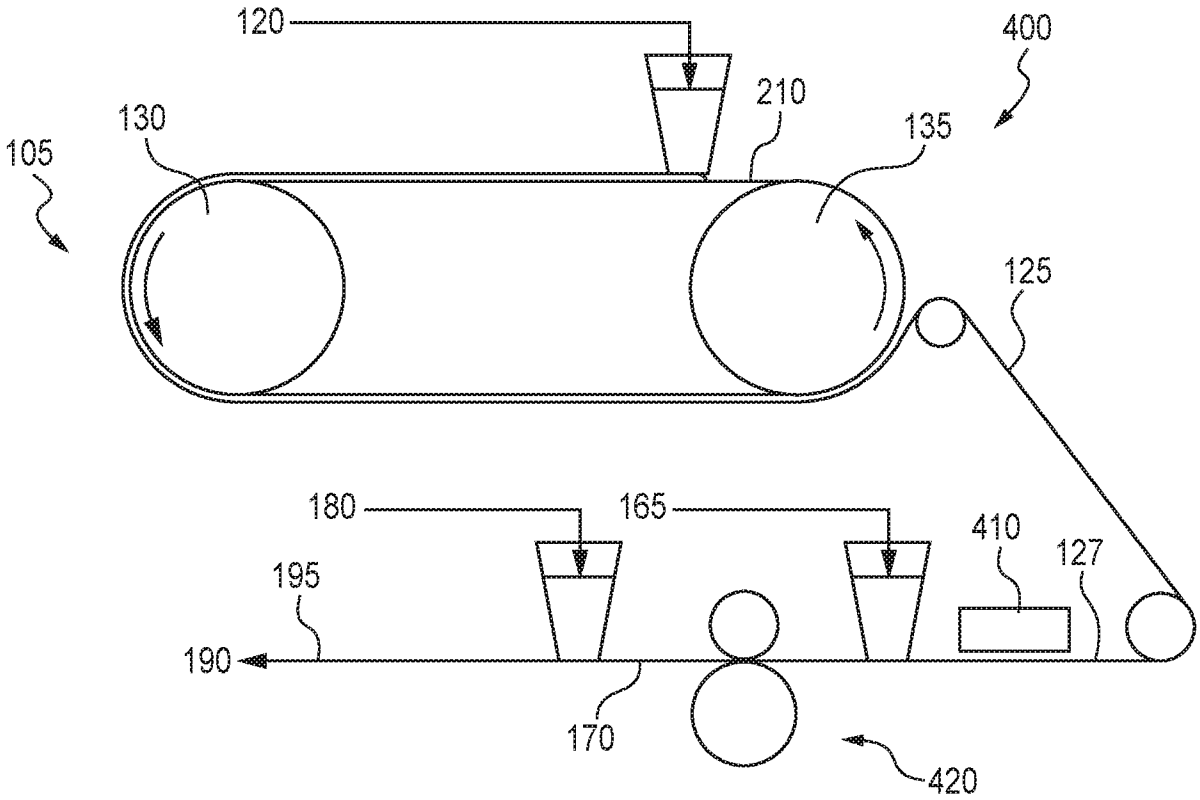
120
400
210
130
135
105
125
180
165
410
127
195
190
170
420

FIG. 9

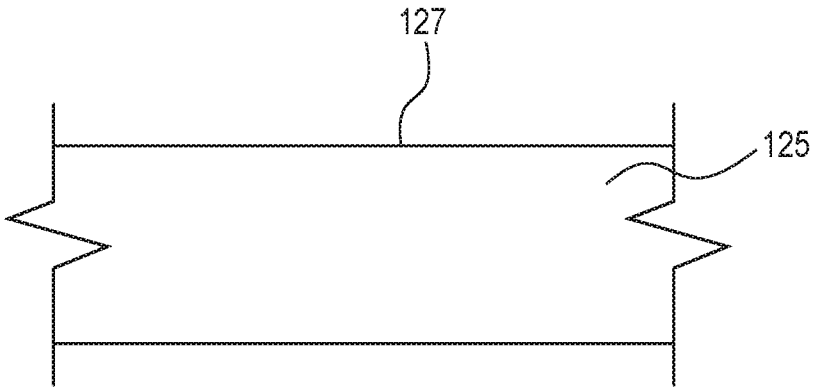
127
125

FIG. 10

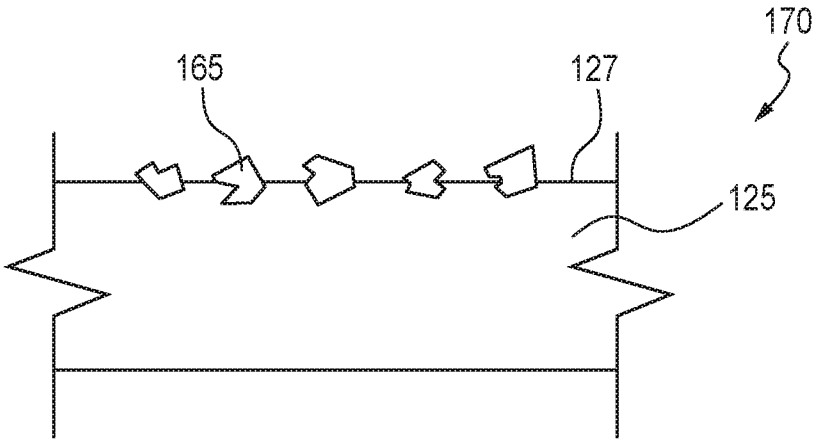

FIG. 11

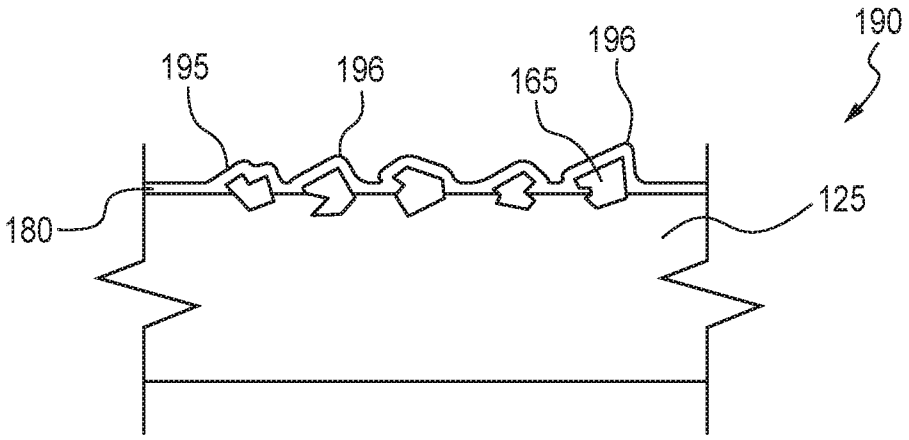

FIG. 12

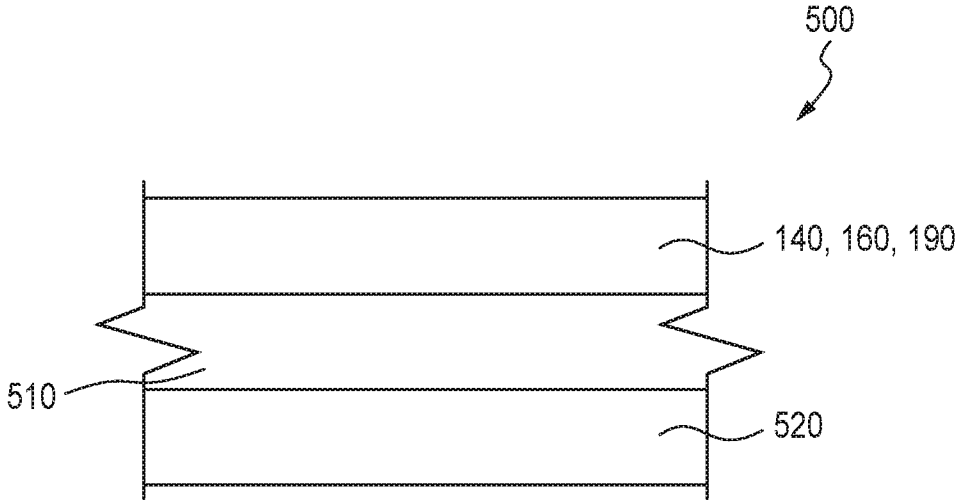

FIG. 13

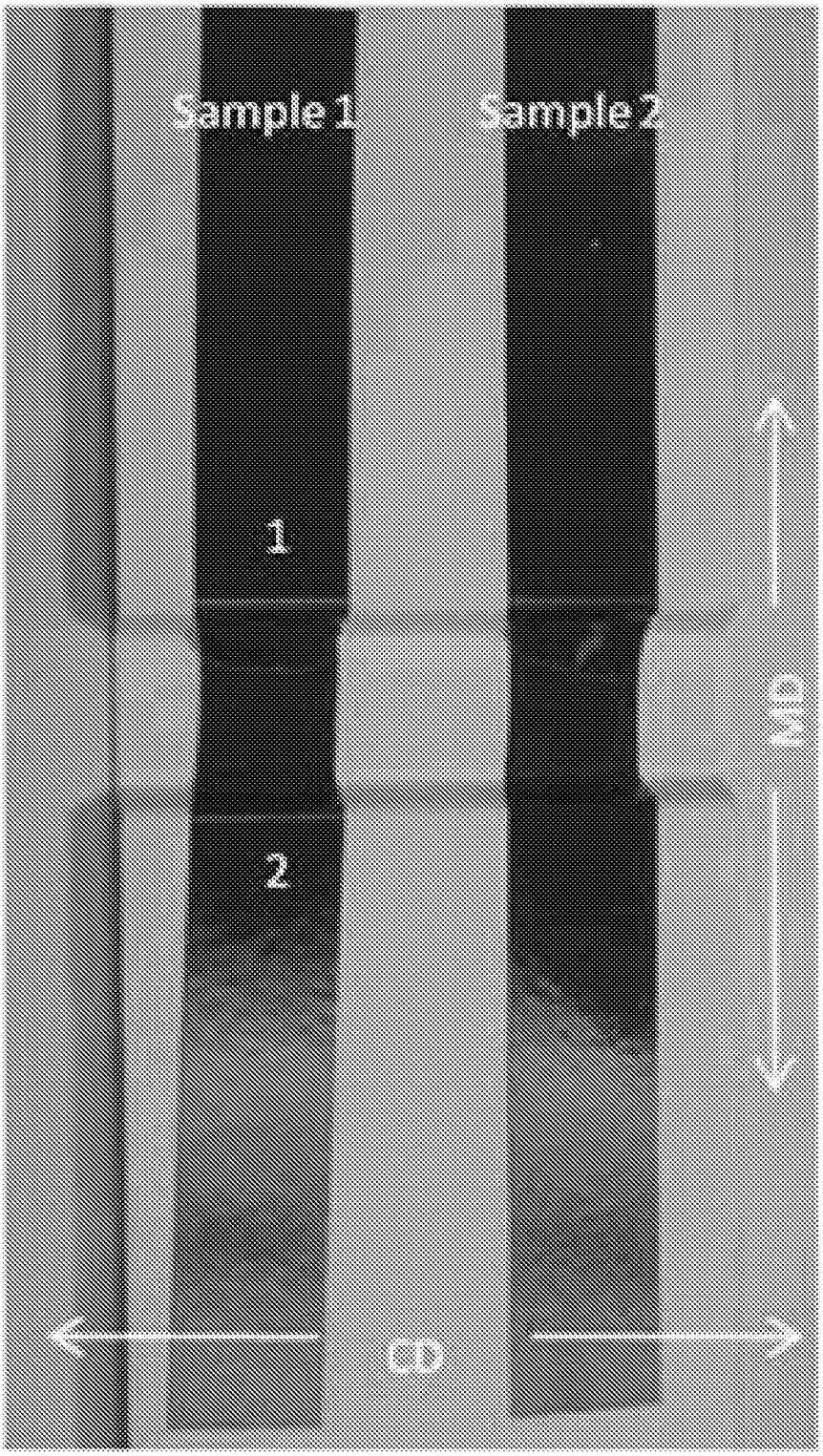

FIG. 14A

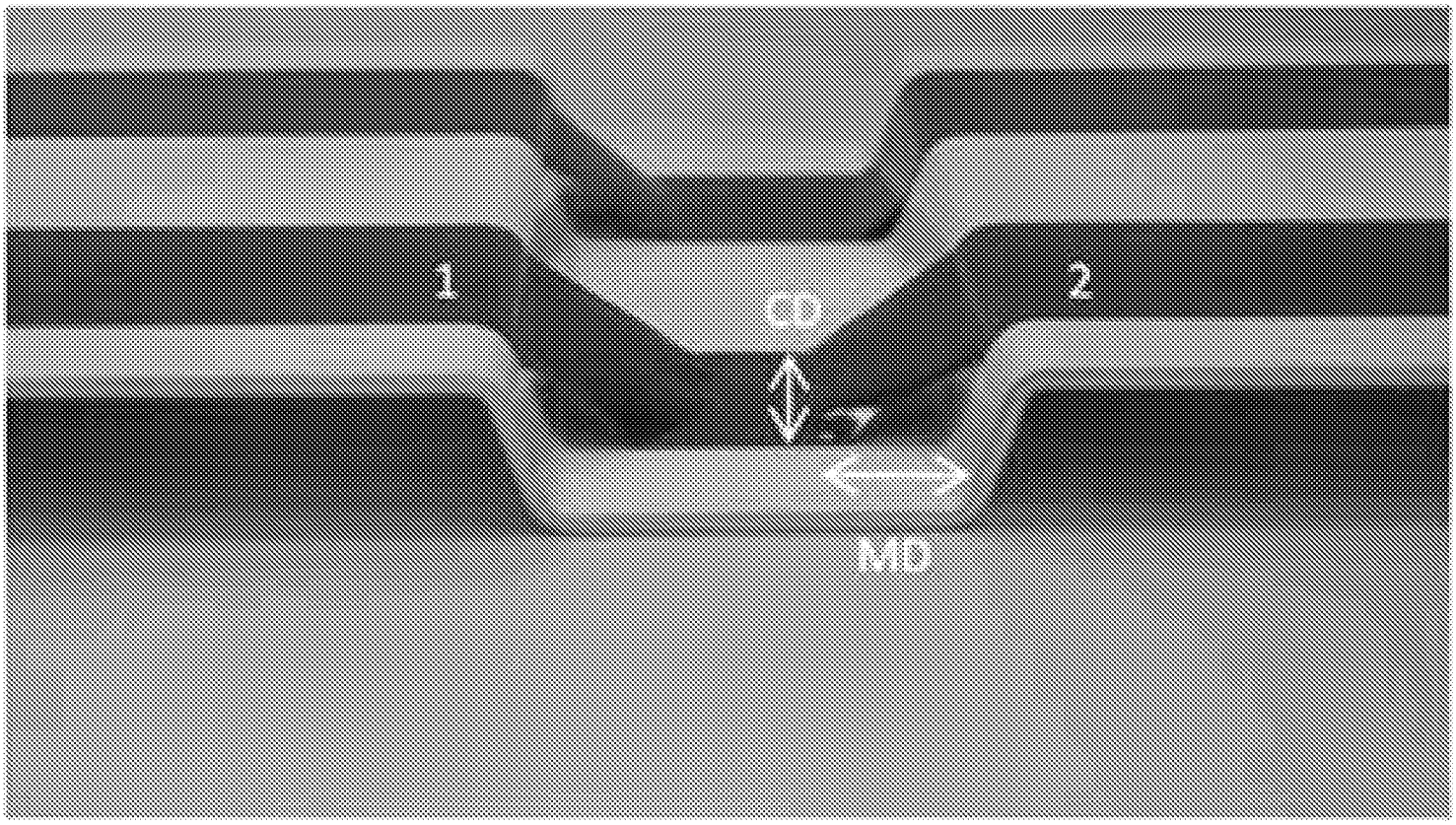

FIG. 14B

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/019960

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C59/04 B29C37/00 C08J5/18
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B29C C08J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/037386 A1 (BONKE DOUGLAS D [US]) 28 March 2002 (2002-03-28) paragraphs [0018], [0051] - [0054]; claims 1,24,26,27; figures 2-5; example 10 -----	1-6
X	US 3 150 031 A (POWELL WILLIAM H) 22 September 1964 (1964-09-22) column 2, lines 29-33 column 2, line 59 - column 3, line 4 column 7, line 74 - column 8, line 57 column 1, lines 10-14 -----	1-8, 29-37
X	US 2016/059512 A1 (PROKSCH TOBIAS [DE] ET AL) 3 March 2016 (2016-03-03) paragraphs [0002], [0007], [0055], [0059], [0068], [6976], [0086], [0095], [0099], [0101]; figures ----- -/--	1-8, 29-31

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 June 2019	05/08/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Frison, Céline

3

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/017241 A1 (ANDERSON JERREL C [US] ET AL) 24 January 2008 (2008-01-24) paragraphs [0078] - [0081], [0086], [0095], [0102]; examples column 8, lines 26-40	1-3,6, 32-37
X	US 5 203 941 A (SPAIN PATRICK L [US] ET AL) 20 April 1993 (1993-04-20) column 1, lines 10-20; claims 1,9; figures	1-8, 29-37
X	WO 98/29237 A1 (DU PONT [US]) 9 July 1998 (1998-07-09) page 1, lines 4-30; claims page 5, line 28 - page 6, line 29; examples	1-8, 29-37
X	WO 91/05660 A1 (AVERY INTERNATIONAL CORP [US]) 2 May 1991 (1991-05-02) page 1, lines 14-19; claims 1,11; examples	1-6
X	WO 96/40480 A1 (AVERY DENNISON CORP [US]; ENLOW HOWARD H [US] ET AL.) 19 December 1996 (1996-12-19) page 36, line 27 - page 37, line 4; claim 1; figures	1,7
A	US 2016/186020 A1 (KLICH PAUL R [US] ET AL) 30 June 2016 (2016-06-30) the whole document	1-8, 29-37

3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/019960

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

7, 8(completely); 1-6, 29-37(partially)

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 7, 8(completely); 1-6, 29-37(partially)

   Textured polymeric film and process for its production

   ---

2. claims: 9-11(completely); 1-6, 29-37(partially)

   Textured polymeric film and process for its production

   ---

3. claims: 12-17(completely); 1-6, 29-37(partially)

   Textured polymeric film and process for its production

   ---

4. claims: 18-21(completely); 1-6, 29-37(partially)

   Textured polymeric film and process for its production

   ---

5. claims: 22-28(completely); 1-6, 29-37(partially)

   Textured polymeric film and process for its production

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2019/019960

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2019/019960

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