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(71) Applicant *(for all designated States except US)*: **3M INNOVATIVE PROPERTIES COMPANY** [US/US]; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

(72) Inventors: **JONZA, James, M.**; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US). **PETT, Todd, G.**; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US). **HEBRINK, Timothy, J.**; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US). **YUST, David, T.**; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US). **FRONEK, Daniel, R.**; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

(74) Agents: **OLSON, Peter, L.** et al.; 3M Center, Office of Intellectual Property Counsel, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

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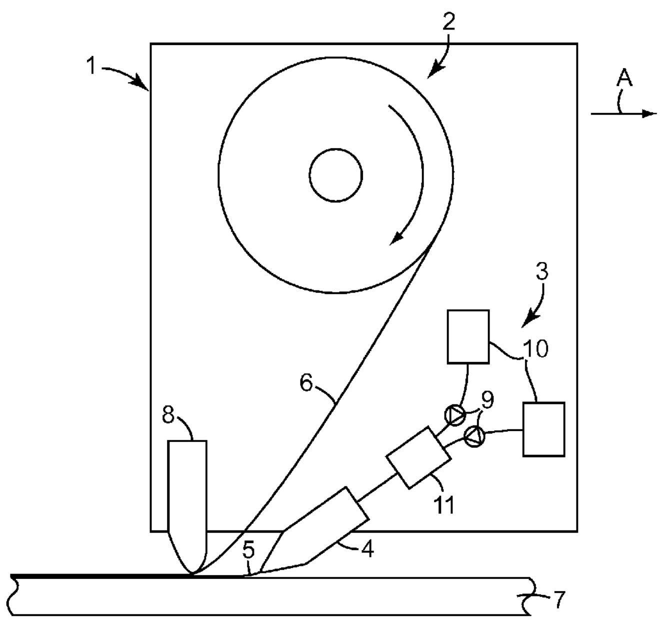

Fig. 1

(57) Abstract: An applicator and method are disclosed for providing a structured surface on a substrate and a substrate having a structured surface created according to the method. The applicator may include a structured surface film dispenser and a flowable material dispenser and preferably includes a die for providing flowable material distribution across substantially the width of the structured surface film. The applicator is adapted to simultaneously dispense the flowable material and the structured surface film.

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APPARATUS AND METHOD FOR PROVIDING A STRUCTURED SURFACE ON A SUBSTRATE

Cross Reference to Related Application

This application claims priority from United States Patent Application No. 61/254900, filed October 26, 2009.

Field of the Invention

The invention relates to an applicator and method for providing a structured surface, and more particularly to an applicator and method adapted to simultaneously dispense a flowable material and a structured surface film.

Background

Structured surfaces have been used in various applications for optical benefits or drag reduction. For example, prismatic structures on the surface of photovoltaic panels reduce reflection and direct more light towards the silicon cells, thus boosting power output. Similar prismatic structures promote fluid flow over a surface resulting in reduced drag when applied to an airplane, automobile, boat, or the like, or to wind or water turbine blades.

The benefits of structured surfaces are typically obtained by creating a structured surface on a thin film and subsequently bonding the film to the desired substrate. However, application of film to large surfaces often results in air pockets between the film and the surface that are detrimental to the performance of the structured surface. In addition, it is expensive to apply both a UV-stable film and adhesive onto a substrate. Ultimately, application of film is often difficult and time-consuming.

United States Patent Publication No. US 2007/0257400 A1 (Stenzel et al.) discloses a tool for generating a microstructured surface in which a pressure roller and flexible matrix with a negative of the microstructure to be generated are arranged so that when the roller passes over a surface, the matrix executes a rolling movement between the roller and layer. A device for accelerating the curing of a curable material is arranged so that it accompanies the movement of the pressure roller and acts on a part of the surface.

producing a transparent wear resistant finish on a smooth flat surface subject to wear and more particularly to a material and method for finishing a floor, such as a wooden athletic game floor.

United States Patent No. 5,175,030 (Lu et al.) discloses a composite plastic article having at least one microstructured surface containing a plurality of utilitarian discontinuities.

United States Patent Publication No. US 2008/0135091 A1 discloses a process for producing solar panels having an antireflective film designed to capture more incident light. The process uses lamination, particularly thermal lamination, to apply a light capturing film onto the front surface of a solar panel.

There is a need to improve the application of a structured surface to a substrate by both simplifying and reducing the cost of the process. Additionally, there is a need to improve the weatherablity of a structured surface on a substrate as well as to maximize the effectiveness of the surface by minimizing air pockets between the film and substrate.

Summary of the Invention

The present invention provides for an applicator comprising a structured surface film dispenser for dispensing a structured surface film and a flowable material dispenser for dispensing at least one flowable material. The flowable material dispenser preferably comprises a die for providing flowable material distribution across substantially the width of the structured surface film, and the applicator is preferably adapted to simultaneously dispense the flowable material and the structured surface film, and more preferably to dispense the flowable material onto at least one of the substrate and the structured surface film.

In addition, the structured surface film dispenser may have an application member for applying pressure to the structured surface film. The application member may include a bar, a roller, or other structures that perform a similar function. In another embodiment, the applicator may have a structured surface film dispenser in combination with a structured surface tooling film. The film may have a series of small grooves or linear prisms (“riblets”), a nano-scale antireflection surface, a matte surface for diffusing light, or any other structured surface.

least one reactive flowable material provided within the flowable material dispenser. Additionally, the applicator may be provided in combination with a wetting aid or an adhesive. In a further embodiment, the applicator may be provided in combination with a flowable material that exhibits a dual-cure mechanism. In another embodiment, the applicator may be provided in combination with at least two flowable materials wherein a first flowable material comprises an isocyanate and a second flowable material comprises a polyol. It may be beneficial to use a carbon dioxide permeable structured surface film when the flowable material includes an isocyanate. The flowable material may include a polyol, polyol with dibutyl tin dilaurate catalyst, UV absorber and hindered amine light stabilizer, multifunctional isocyanate, silicone elastomer, moisture cure silicone, silicone containing a radiation sensitive photo initiator, silicone SPOx, epoxide, PDMS adhesive, soap and water, alcohols, alcohol and water mixtures, a wetting aid, or other suitable materials.

In another embodiment, the structured surface film may be a polyolefin structured surface film. Alternatively, the structured surface film may include polyamides, polylactic acids, thermally induced phase separation membranes, polyethylene terephthalates, ethylene/octenes, ethylene/hexenes, other ethylene copolymers, and poly(methyl methacrylates). Alternatively, the structured surface film may include polyurethanes, polyureas, polyvinyl alcohols, polyvinyl acetates, polyalkylene oxides, polyacrylic acids, propylene copolymers with polar comonomers, and microporous membranes including thermally induced phase separation membranes. The structured surface may include clays, calcium carbonate, mineral fillers, foaming agents, ionomeric resins, water soluble polymers, and water swellable polymers. Polymers are defined as including those having additional comonomers. Furthermore, the applicator may be provided in combination with a structured surface film having a higher moisture vapor transmission rate than polyolefins.

In a further embodiment, the structured surface film may have a structured surface facing away from the substrate when dispensed. The structured surface film may have an adhesive on the surface opposite that of the structured surface.

The present invention provides for a method of providing a structured surface comprising the steps of: a) providing a substrate; b) applying a structured surface film to substrate and on at least one of the substrate and the film; and c) at least partially curing the flowable material for a period of time.

In a further embodiment, the flowable material may be distributed across substantially the width of the structured surface film. Additionally, the substrate may be primed prior to application of the structured surface. The structured surface film may be removed to provide a structured surface on the substrate. Alternatively, the flowable material may be an adhesive.

The method of providing a structured surface is suitable for providing a structured surface on a photovoltaic panel, a solar thermal panel, a turbine blade, an automobile component, a plane component, a train component, a human powered vehicle component, windows and other substrates.

The present invention includes a photovoltaic panel, a solar thermal panel, and a turbine blade comprising a structured surface created on the panel or blade according to the method of the present invention.

Brief Description of the Drawings

The present invention is described with reference to the following figures in which:

FIG. 1 is a schematic view of a structured surface applicator.

FIG. 2A is a perspective view of an application member comprising a bar.

FIG. 2B is a perspective view of an application member comprising a roller.

FIG. 2C is a perspective view of an application member comprising a curved roller.

FIG. 3 is a perspective view of a riblet structured surface tooling film.

FIG. 4 is a perspective view of a riblet structured surface on a carrier.

FIG. 5 is a perspective view of a riblet structured surface on an adhesive-backed carrier.

FIG. 6 is a perspective view of a structured surface tooling film as it is removed to expose the final structured surface on the substrate.

Detailed Description of the Preferred Embodiment

The present invention provides for a structured surface applicator capable of creating a structured surface on a substrate. The applicator, in accordance with one embodiment of the invention, comprises a structured surface film dispenser for dispensing flowable material. The flowable material dispenser includes a die for providing flowable material distribution across substantially the width of the structured surface film. With the present structured surface applicator, the cost of UV-stable film, adhesives, and process steps associated with the conventional application of structured surface films can be reduced by applying a flowable material and a structured surface tooling film directly onto a substrate. The applicator may be used in combination with wetting agents or other flowable materials to facilitate application of a structured surface free or substantially free of air pockets. Furthermore, the present invention improves upon prior applicators by not requiring rapid curing of the surface material.

An applicator 1 including a structured surface film dispenser 2 and flowable material dispenser 3 is illustrated in FIG. 1. The applicator is adapted to dispense the flowable material 5 and the structured surface film 6 simultaneously, and to dispense the flowable material 5 onto at least one of the substrate 7 and the structured surface film 6. These and other features of the invention will be described individually below.

I. Structured Surface Film Dispenser

The structured surface film 6 is preferably wound on a cylindrical core and loaded into the structured surface film dispenser 2. The cylindrical core rotates as the structured surface film 6 is unwound while the dispenser is moved in direction A. Alternatively, the substrate may move while the dispenser remains stationary or both the substrate and dispenser may move.

According to one embodiment of the present invention, the structured surface film dispenser 2 includes an application member 8 for applying pressure to the structured surface film 6. The application of pressure to the film 6 assists in the removal of air pockets that would otherwise detrimentally affect the performance of the final structured surface. Preferably, the application member 8 comprises a rigid bar 20 with a leading edge having a small radius corner, as illustrated in FIG. 2A at 21. The rigidity of the bar assists in creating a final surface of substantially uniform thickness. Alternatively, the application member 8 may include a roller 21 as shown in FIG. 2B or a curved roller 22 as shown in FIG. 2C, or of other structures that perform a similar function, or a combination of any of the foregoing.

facilitate application of the film to the particular topography of a substrate 7. An application member 8 made of rubber or another resilient material, and having a radius that matches or nearly matches the crossweb curvature of a substrate, may facilitate application of a structured surface film to a curved substrate such as an airplane wing or turbine blade. A curved roller 22, as illustrated in FIG. 2C, may achieve such a function. In general, the application member may thus be matched or nearly matched to the profile of the substrate to improve application performance.

Preferably, the structured surface film readily conforms to any crossweb curvature of a substrate. For downweb curvature of a substrate in the direction of riblets, for example, thin or compliant films such as those including ethylene/octene, ethylene/hexene, other ethylene copolymers, propylene/ethylene or other propylene copolymers of lower modulus than polypropylene should be used

II. Flowable Material Dispenser

The flowable material dispenser preferably includes one or more means of forcing the flowable material 5 through the die 4 and onto at least one of the substrate 7 and the structured surface film 6. Preferably, the flowable material 5 is dispensed at a predetermined rate proportional to the desired final thickness of the flowable material layer and the rate that the structured surface film 6 is dispensed. A metering pump 9 may be used to force the flowable material from a reservoir 10 through the die 4. Disposable cartridges serve as convenient reservoirs 10 for flowable materials. The flowable material 5 can be forced through the die 4 by a peristaltic pump, a linear drive pump, a manually activated pump, a pressure pot, a gravity-fed system, or any other system that enables the flowable material 5 to be dispensed.

The flowable material dispenser 3 may include a mixer 11 for mixing the flowable material 5 just prior to it being dispensed. This is particularly useful for flowable materials that are made from two or more components. The mixer 11 may be a static mixer commonly used with such flowable materials, or a dynamic mixer that is powered by a motor. The mixer 11 ensures that flowable materials, such as reactive polymers, are properly mixed so as to cure as desired or may be helpful to eliminate air-pockets or produce a consistent layer when using a one-part material.

The mixture of a two-part reactive flowable material that is initially dispensed from a device does not always have the desired mixing ratio of the reactants. Preferably, the flowable material dispenser 3 ensures that all flowable material 5 that is dispensed has the desired mixing ratio. This may be accomplished with the use of a delay chamber that collects the flowable material that is initially dispensed, and only when the delay chamber is filled does the subsequent flowable material get dispensed onto the film or the substrate, or both. An example of such a feature is described by United States Patent No. 6,244,740 (Wagner et al.) which discloses a mixer for multi-component pastes, incorporating a delay chamber, the entire contents of which is incorporated herein by reference.

The flowable material 5 is preferably a curable polymeric material that can be molded into a desired shape by the use of a structured surface tooling film. Alternatively, the flowable material is an adhesive for bonding a structured surface film to a substrate or is a wetting agent for facilitating application of a structured surface film free of air pockets.

III. Die

The flowable material dispenser 3 includes a die 4 that distributes flowable material across substantially the entire width of the structured surface film 6. Application of the flowable material 5 across substantially the width of the structured surface film 6 reduces the pressure and overall effort otherwise required to spread the flowable material 5 on the substrate 7 without producing air pockets. This type of die also tends to provide more even distribution of the flowable material than if the material is dispensed at one or more discrete locations and then spread by the pressure of the structured surface film against the substrate.

In a preferred embodiment, the die 4 is constructed of polytetrafluoroethylene, polypropylene or polyethylene and has one or more openings out of which the flowable material 5 is dispensed. The die 4 may have a single opening or a plurality of smaller openings positioned and shaped so as to facilitate uniform flowable material distribution. A coat hanger or Winter die geometry is preferred. Such geometries are described in further detail in H. H. Winter and H. G. Fritz, *Design of Dies for the Extrusion of Sheets* is incorporated herein by reference.

IV. Structured Surface Materials and Methods

The present invention structured surface applicator is capable of providing a structured surface suitable for a variety of applications. The combination of structured surface film and flowable material can be selected based on the desired performance results and other parameters of a particular application.

A. Application of a Structured Surface Using a Structured Surface Tooling Film

The applicator of the present invention may provide a structured surface having a riblet pattern. FIG. 3 illustrates a perspective view of a structured surface tooling film 30 having a riblet pattern. The riblets preferably have peak to valley measurements of less than 2500 microns, more preferably less than 250 microns and most preferably less than 100 microns. The portion of the structured surface tooling film beneath the riblet structure, sometimes referred to as the "land" area, is preferably at least as thick as the peak to valley measurement of the riblet structure. Polypropylene is a preferred material for the structured surface tooling film due to its low cost and its release properties when urethanes are used to form the cured structured surface on a substrate. When urethanes are not used to form the structured surface, it may be advantageous to coat the polypropylene structured surface tooling film with a fluoropolymer or silicone. Alternatively, examples of other structured surface tooling films may include those made with polyethylene, polystyrene or fluoropolymers.

In one embodiment, the flowable materials may include a reactive mixture of a polyol, a multifunctional isocyanate, a catalyst and optionally a UV absorber and hindered amine light stabilizer. The catalyst may be a tertiary amine such as dimethylcyclohexylamine or an organometallic compound such as di-n-butyl tin dilaurate or bismuth octonoate. Di-n-butyl tin dilaurate is a preferred catalyst. Preferably, the flowable materials include an aliphatic polyester polyol available from King Industries, Inc. of Norwalk, Connecticut under the designation KFlex 188 and a multifunctional

AG, of Leverkusen, Germany under the designation Desmodur N3300.

Preferably, a polypropylene riblet structured surface tooling film 30 is loaded into the structured surface film dispenser 2. A water based silica nanoparticle primer may be applied to the substrate 7 prior to application of the flowable material 5 to promote adhesion. U.S. Patent Application No. 61/328939 describes an exemplary water based silica nanoparticle primer, and is incorporated herein by reference. In another embodiment, a silane primer may be applied. The structured surface tooling film 6 is then applied to the substrate with the structured surface facing towards the substrate while a flowable material 5 is simultaneously applied to at least one of the film 6 or the substrate 7 at a predetermined rate. Application of pressure to the structured surface tooling film molds the flowable material into a riblet structured surface. The flowable material 5 is at least partially cured for a period of time. As illustrated in FIG. 6, the structured surface tooling film 61 may be removed to expose the final structured surface 62 on the substrate 63. The structured surface tooling film may be removed manually. Alternatively, the applicator may be adapted to remove the tooling film from the substrate.

It is advantageous that the structured surface film allows the permeation of carbon dioxide, a byproduct of the isocyante reaction in the presence of moisture.

The final structured surface preferably has riblets with peak to valley measurements of less than 2500 microns, more preferably less than 250 microns and most preferably less than 100 microns.

In another embodiment, a two-part thermally curable silicone elastomer, such as that available from Momentive Performance Materials of Albany, New York under the designation RTV615, may be used as the flowable material 5. A water based silica nanoparticle primer may be applied to the substrate 7 prior to application of the silicone elastomer to promote adhesion. In another embodiment, a silane primer may be applied to the substrate 7 prior to application of the silicone elastomer to promote adhesion. After the silicone elastomer is at least partially cured, the structured surface tooling film 6 is removed, leaving a structured surface on the substrate.

Alternatively, a moisture curable silicone such as that available from Dow Corning Corp. of Midland, Michigan under the trade designation DOW CORNING 734 may be used as the flowable material 5. It is advantageous to use a structured surface tooling film curable silicone.

Alternatively, an epoxide may be used as a flowable material to form a polyepoxide structured surface. However, epoxies have shown less than desirable weathering characteristics.

Additives may be chosen to increase the moisture vapor transmission rate of the structured surface film to enhance moisture curing. Examples may include clays, mineral fillers, foaming agents, ionomeric resins, water soluble polymers or water swellable polymers. Alternatively, higher moisture vapor transmission rate films such as those made of polyurethanes, polyureas, polyvinylalcohols, polyvinylacetates, polyalkylene oxides, polyacrylic acids, propylene copolymers with polar comonomers, or microporous membranes including thermally induced phase separation membranes may be used.

In another embodiment, a silicone elastomer with a dual-cure mechanism may be used as the flowable material 5. The silicone contains a radiation sensitive photoinitiator. If the photoinitiator is activated by sunlight the surface of the silicone begins to cure through the structured surface tooling film 6 and allows the film 6 to be quickly removed. Removal of the structured surface tooling film 6 allows a moisture curing mechanism to operate more quickly due to greater moisture diffusion with the exposed structured surface. Alternatively, a UV or gamma source could be used.

B. Application of a Pre-Made Structured Surface Film

In another embodiment, the present invention may be used for applying pre-made structured surface films to a substrate, but in this embodiment the structured surface of the film normally faces away from the substrate and not toward it as in the embodiments described above. FIG. 4 illustrates a perspective view of a structured surface film 40 having a riblet surface 41 on a carrier 42. The pre-made riblet surface 41 is preferably made of a polyurethane on a carrier 42 of polyethylene terephthalate, poly(methyl methacrylate) or other suitable material. Preferably, the surface of the film opposite the structured surface is flat and is nitrogen corona treated to greater than 1 J/cm^2 or otherwise primed for improved adhesion. Polyurethane or other suitable flowable adhesive material 5 is used in combination with the flowable material dispenser 3 to adhere the riblet structured surface film to the substrate. Preferably, the flowable adhesive material 3 is substrate prior to application of the flowable material 5 to promote adhesion. In another embodiment, a silane coupling agent may be wiped onto the substrate 7 prior to application. The riblet structured surface film 40 and polyurethane 5 are dispensed as described above with the exception that the structured surface of the structured surface film 6 is facing away from the substrate 7. The polyurethane 5 is cured, bonding the pre-made riblet structured surface film 6 to the substrate.

Alternatively, a pre-made riblet structured surface film 40 may be made from a riblet structured curable silicone elastomer 41 on a carrier film 42 of polyethylene terephthalate, poly(methyl methacrylate), or other suitable material. Preferably, the structured surface film and substrate are primed as described above. The silicone elastomer used to bond the structured surface film to the substrate may be cured by any method including thermal, moisture, ultraviolet or dual curing.

A pre-made structured surface film already having an adhesive on the surface opposite the structured surface may be used in combination with the present invention. FIG. 5 illustrates a perspective view of a structured surface film 50 having a riblet surface 51 and an adhesive 53 on a carrier 52. The pre-made film 50 may be made of polyurethane, silicone elastomer, or other suitable material. A PDMS or SPOx adhesive, as described in United States Patent No. 6,730,397 (Melancon et al.), which is incorporated herein by reference, may be desirable for use as the adhesive 53 due to its self-wetting behavior and long term ultraviolet stability. Alternatively, other pressure sensitive adhesives may be used as well.

A flowable material 5 that aids in wetting out the pressure sensitive adhesive to the substrate 7 may be used in combination with the flowable material dispenser 3. The wetting agent aids in removing the air between the substrate 7 and structured surface film 6 and evaporates or is absorbed over time. Flowable materials found to aid the wet out of the adhesive to the substrate 7 include dilute solutions of soap and water, or alcohols or alcohol and water mixtures. Alternatively, plasticizer may be a suitable wetting agent to aid in bubble-free application of the structured surface.

In another embodiment, the applicator 1 of the present invention may be used in combination with a structured surface film 6 having a matte surface for diffusing light. The creation of a matte structured surface on a window, for example, allows light to pass through to provide illumination while making the window appear diffuse for privacy purposes. A structured surface film having a matte structure is suitable for use with any of the preceding materials and methods.

Alternatively, the applicator 1 of the present invention may be used in combination with a structured surface film 6 having a nano-scale antireflection surface. A nano-scale antireflection tooling film can be used for any application in which increased light transmission or reduced glare is desired such as for window applications. Such a film is suitable for use with any of the preceding materials and methods.

V. Exemplary Uses and Benefits

The present invention is useful for providing a structured surface having riblets. Such a surface reduces reflection and causes more light to be transmitted to a substrate such as a photovoltaic panel or a solar thermal collector, for example. Application of a KFlex 188 riblet structure having 53 degree angle tips directly to a piece of glass lowered the measured percent reflection of incident light from 4.19% to 0.43%. This result was obtained using a mixture consisting of 7.8 g of an aliphatic polyester polyol, available from King Industries, Inc. of Norwalk, Connecticut under the designation K-Flex 188, 6.2 g of a multifunctional isocyanate based on hexamethylene diisocyanate, available from Bayer MaterialScience AG, of Leverkusen, Germany under the designation Desmodur N3300 and 1 drop of dibutyl tin dilaurate catalyst, available from Air Products, Allentown, PA under the designation DABCO T-12. A blend of UV absorbers available from Ciba Specialty Chemicals, Tarrytown, NY (2.0 wt. % TINUVIN 405 and 1.0% wt TINUVIN 123) were predissolved in the K-Flex 188. The weight percent of UV absorbers was based on the K-Flex 188. All ingredients were preheated to 50° C.

The average percent reflection of the film was measured using a PerkinElmer Lambda 950 UV-VIS-NIR Scanning Spectrophotometer. The film was prepared by applying Yamato Black Vinyl Tape #200-38 (obtained from Yamato International Corporation, Woodhaven, MI) to the backside of the sample. Clear poly (methyl predetermined was utilized to establish the percent reflection from the black tape. The black tape was laminated to the backside of the sample using a roller to ensure no air bubbles were trapped between the black tape and the sample. The sample was placed in the scanning spectrophotometer so that the non-tape side was against the aperture to measure the front surface total percent reflection (specular and diffuse) by an integrating sphere detector. The percent reflection was measured at an 8° incident angle. Average percent reflection was calculated by subtracting the percent reflection of the black tape for the wavelength range of 400-800nm.

Application of a silicone elastomer riblet structure directly to a piece of glass lowered the measured percent reflection of incident light from 4.09% to 0.36%. This result was obtained using a two part thermally curable silicone elastomer, available from Momentive Performance Materials of Albany, New York under the designation RTV615. The test method described above was used to obtain the measured percent reflection.

Reduced reflection and increased light transmittal may result in an increased power output or temperature of a photovoltaic panel or solar thermal collector respectively.

A riblet structured surface is also useful for drag reduction applications. Such microstructured surfaces promote fluid flow over a surface resulting in reduced drag when applied to an automobile, boat, or the like, or to wind or water turbine blades. The present invention provides a structured surface on such substrates. The present invention may be particularly useful in creating a structured surface on vehicle components that serve dual functions such as airplane wings, roofs, hoods and sides of automobiles, human powered vehicles, or train cars with photovoltaic cells at the surface. In such applications, the structured surface can simultaneously provide drag-reduction while directing light to photovoltaic cells.

The present invention is also useful in providing matte surfaces for diffusing light, nano-scale antireflection surfaces or other structured surfaces.

Because the present invention allows for a flowable material to be applied directly to a substrate, it is possible for the system to conform to and fill textured surfaces, such as textured front glass of a photovoltaic panel, with a reduced possibility of trapping air bubbles.

structured surface films by simultaneously dispensing a structured surface film with an adhesive on the surface opposite that of the structured surface and a wetting agent. The wetting agent aids in removing the air between the substrate and the structured surface film and evaporates or is absorbed over time.

The present invention allows for the option to refurbish a substrate on site. The front surface of a solar photovoltaic panel or solar thermal panel, for example, can be reconditioned resulting in a return to or increase in the original power output level of the panel.

The present invention improves upon prior applicators by not requiring rapid curing of the surface material. Because the structured surface tooling film may stay in contact with a reactive resin system for an extended period, minimal catalyst levels can be used allowing for greater environmental durability. In addition, the high costs associated with the use of both a UV-stable film and adhesive may be reduced because the present invention provides a structured surface directly on a substrate without the need for a UV-stable film. In addition, structured surface tooling film may remain on the substrate until just before use acting as a protective liner during installation or transportation.

The present invention has now been described with reference to several embodiments thereof. It will be apparent to those skilled in the art that many changes can be made without departing from the scope of the invention. Thus, the scope of the present invention should not be limited to the structures described herein, but only by structures described by the language of the claims and the equivalents of those structures.

What is claimed is:

1. An applicator comprising:
a structured surface film dispenser for dispensing a structured surface film; and
a flowable material dispenser for dispensing at least one flowable material;
wherein the flowable material dispenser comprises a die for providing flowable material distribution across substantially the width of the structured surface film; and
wherein the applicator is adapted to simultaneously dispense the flowable material and the structured surface film, and to dispense the flowable material onto at least one of the substrate and the structured surface film.

2. The applicator of claim 1, wherein the structured surface film dispenser comprises an application member for applying pressure to the structured surface film.

3. The applicator of claim 2, wherein the application member is a bar.

4. The applicator of claim 2, wherein the application member is a roller.

5. The applicator of claim 1, in combination with a structured surface film, wherein the film comprises a tooling film.

6. The applicator of any of claim 1, in combination with a structured surface film, wherein the film comprises riblets.

7. The applicator of claim 1, in combination with a structured surface film, wherein the structured surface film comprises a nano-scale antireflection surface.

wherein the structured surface film comprises a matte surface for diffusing light.

9. The applicator of claim 1, in combination with at least one reactive flowable material provided within the flowable material dispenser.

10. The applicator of claim 1, in combination with at least one flowable material comprising a wetting aid provided within the flowable material dispenser.

11. The applicator of claim 1, in combination with at least one flowable material comprising an adhesive provided within the flowable material dispenser.

12. The applicator of claim 1, in combination with at least one flowable material that exhibits a dual-cure mechanism.

13. The applicator of claim 1, in combination with at least two flowable materials, wherein a first flowable material comprises an isocyanate and a second flowable material comprises a polyol.

14. The applicator of claim 1, in combination with a carbon dioxide permeable film.

15. The applicator of claim 1, in combination with at least one flowable material selected from the group consisting of a polyol, polyol with dibutyl tin dilaurate catalyst, UV absorber and hindered amine light stabilizer, multifunctional isocyanate, silicone elastomer, moisture cure silicone, silicone containing a radiation sensitive photo initiator, silicone SPOx, epoxide, PDMS adhesive, soap and water, alcohols, alcohol and water mixtures, and a wetting aid.

16. The applicator of claim 1, in combination with at least one structured surface film wherein the film comprises a material selected from the group consisting

water soluble polymers, and water swellable polymers.

17. The applicator of claim 1, in combination with a structured surface film, wherein the film comprises a polyolefin.

18. The applicator of claim 1, in combination with a structured surface film having a higher moisture vapor transmission rate than polyolefin.

19. The applicator of claim 1, in combination with at least one structured surface film wherein the film comprises a material selected from the group consisting of polyamides, polylactic acids, thermally induced phase separation membranes, polyethylene terephthalates, ethylene/octenes, ethylene/hexenes, other ethylene copolymers, and poly(methyl methacrylates).

20. The applicator of claim 1, in combination with at least one structured surface film wherein the film comprises a material selected from the group consisting of polyurethanes, polyureas, polyvinyl alcohols, polyvinyl acetates, polyalkylene oxides, polyacrylic acids, propylene copolymers with polar comonomers, and microporous membranes including thermally induced phase separation membranes.

21. The applicator of claim 1, in combination with a structured surface film, wherein the structured surface film comprises a structured surface facing away from the substrate when dispensed.

22. The applicator of claim 21, wherein the film comprises an adhesive on the surface opposite that of the structured surface.

23. A method of providing a structured surface comprising the steps of:
providing a substrate;

providing a flowable material on at least one of the substrate and the film; and at least partially curing for a period of time.

24. The method of claim 23, further comprising the step of distributing the flowable material across substantially the width of the structured surface film.

25. The method of claim 23, further comprising the step of priming the substrate.

26. The method of claim 23, further comprising the step of removing the structured surface film to provide a structured surface on the substrate.

27. The method of claim 23, wherein the flowable material is an adhesive.

28. The method of claim 23, wherein the substrate is selected from the group consisting of a photovoltaic panel, a solar thermal panel, a turbine blade, an automobile component, a plane component, a boat component, a window, a train component, and a human powered vehicle component.

29. A photovoltaic panel comprising a structured surface created on the panel according to the method of claim 26.

30. A solar thermal panel comprising a structured surface created on the panel according to the method of claim 26.

31. A turbine blade comprising a structured surface created on the blade according to the method of claim 26.

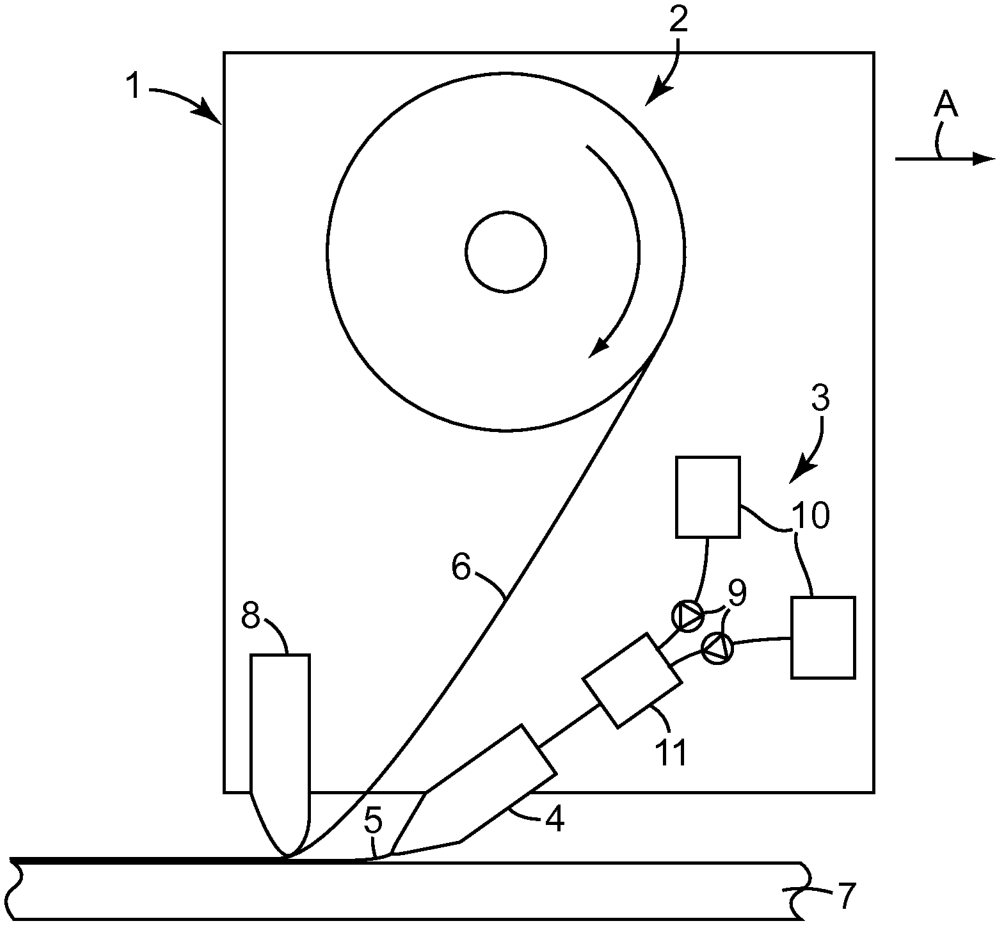

Fig. 1

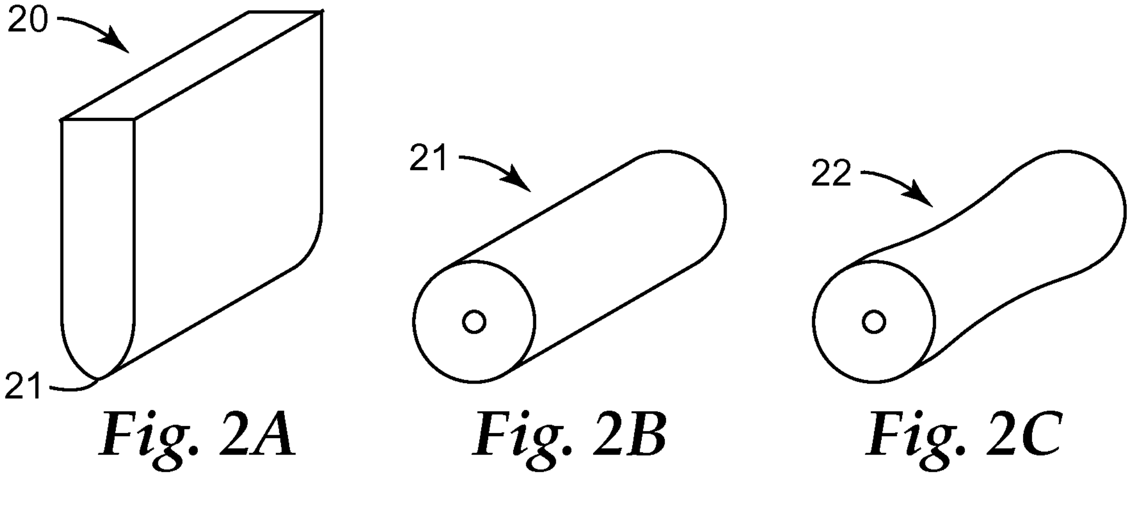

Fig. 2A *Fig. 2B* *Fig. 2C*

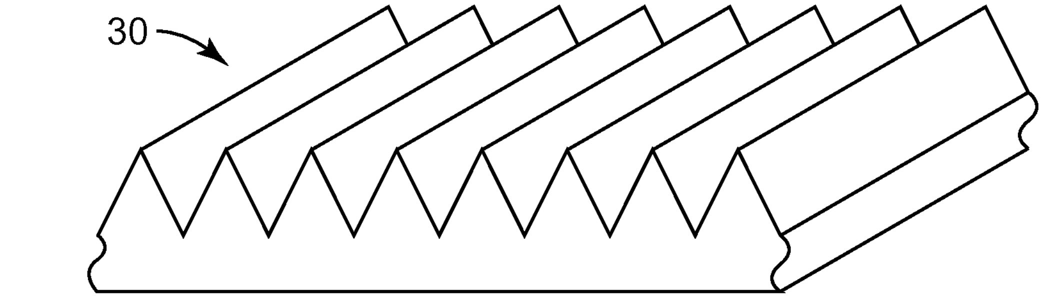

Fig. 3

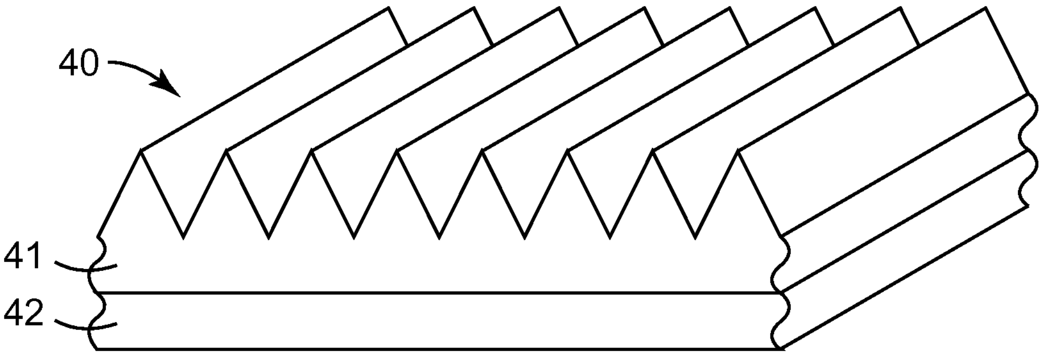

Fig. 4

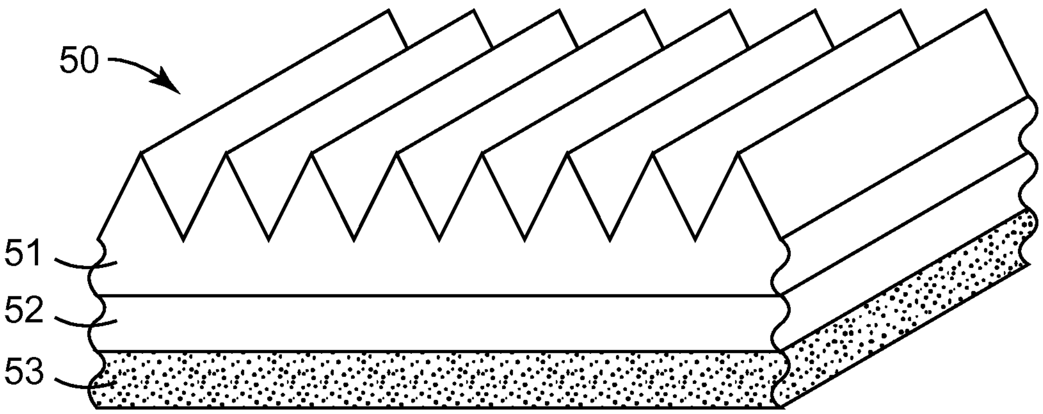

Fig. 5

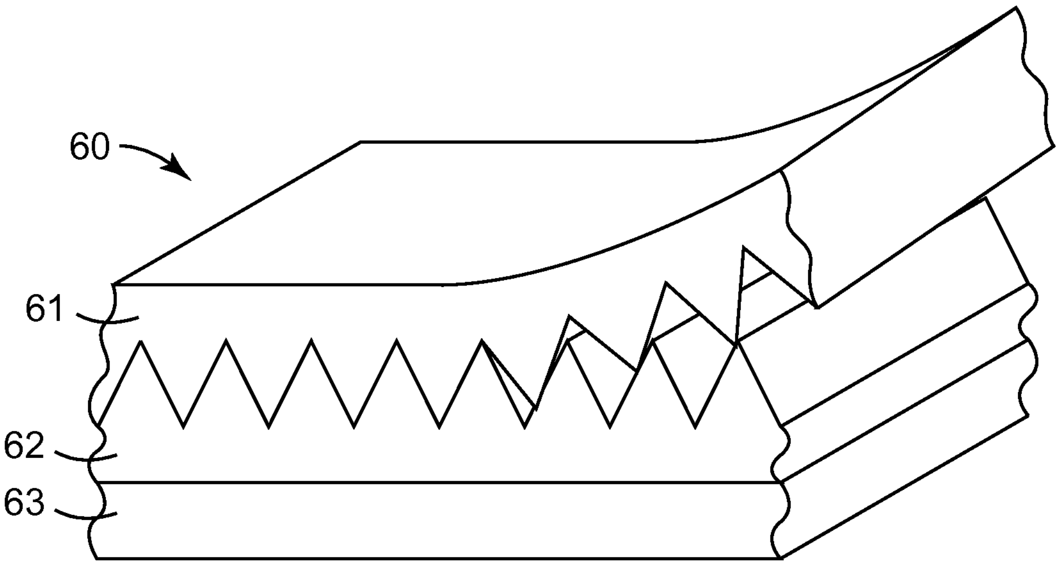

Fig. 6