



(51) International Patent Classification:

H02S 20/25 (2014.01) B32B 27/32 (2006.01)

B32B 7/05 (2019.01) B32B 27/12 (2006.01)

B32B 27/08 (2006.01) B32B 38/00 (2006.01)

(21) International Application Number:

PCT/US2022/032016

(22) International Filing Date:

02 June 2022 (02.06.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/196,568 03 June 2021 (03.06.2021) US

63/197,115 04 June 2021 (04.06.2021) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM,

(54) Title: ROOFING MODULE SYSTEM

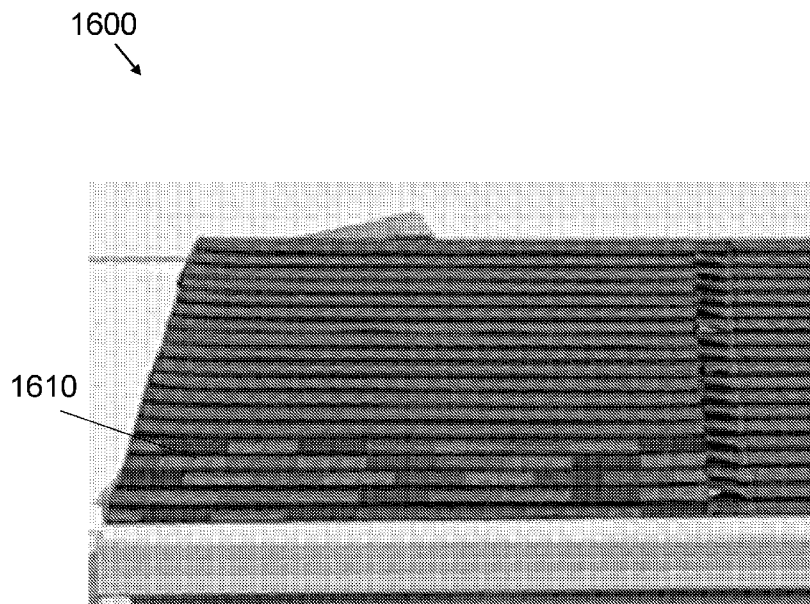


FIG. 27

(57) Abstract: A system includes a plurality of roofing modules and a plurality of photovoltaic modules. The roofing modules include a first layer and a second layer. The first layer has a first surface that is textured. The roofing modules are configured to be installed on the roof deck of a structure proximate to the photovoltaic modules. An appearance of the roofing modules aesthetically matches an appearance of the photovoltaic modules when viewed from a vantage point located at a ground level of the structure.

TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

ROOFING MODULE SYSTEM

Cross-Reference to Related Application

5 This application is a Section 111(a) application relating to and claiming the benefit of commonly-owned, co-pending U.S. Provisional Patent Application Serial No. 63/196,568, filed June 3, 2021, entitled “FLEXIBLE AND CUTTABLE ROOFING MODULES,” and commonly-owned, co-pending U.S. Provisional Patent Application Serial No. 63/197,115, filed June 4, 2021, entitled “PHOTOVOLTAIC MODULE WITH TEXTURED SUPERSTRATE PROVIDING
10 SHINGLE-MIMICKING APPEARANCE,” the contents of each which are incorporated herein by reference in its entirety.

Field of the Invention

 The present invention relates to roofing modules, and, more particularly, flexible and
15 cuttable roofing modules aesthetically matched with photovoltaic modules.

Background

Photovoltaic systems having solar panels are commonly installed on roofing of structures.

Summary

20 In some embodiments, a system includes a plurality of roofing modules, each of the roofing modules includes a first layer wherein the first layer includes a first surface, and a second surface opposite the first surface, wherein the first surface is textured, and a second layer, wherein the second layer is juxtaposed with the second surface of the first layer, wherein each of the roofing

modules does not include a solar cell; and a plurality of photovoltaic modules, each of the plurality of photovoltaic modules includes at least one solar cell, an encapsulant encapsulating the at least one solar cell, wherein the encapsulant of the photovoltaic module includes a first surface and a second surface opposite the first surface of the encapsulant of the photovoltaic module, a
5 frontsheat, wherein the frontsheat includes a first surface, and a second surface opposite the first surface of the frontsheat, wherein the second surface of the frontsheat is juxtaposed with the first surface of the encapsulant, wherein the first surface of the frontsheat is textured, and a backsheat juxtaposed with the second surface of the encapsulant of the photovoltaic module, wherein the photovoltaic modules are configured to be installed on a roof deck of a structure, wherein the
10 roofing modules are configured to be installed on the roof deck proximate to the photovoltaic modules, and wherein an appearance of the roofing modules aesthetically matches an appearance of the photovoltaic modules when viewed from a vantage point located at a ground level of the structure.

In some embodiments, the first layer is composed of a polymer. In some embodiments,
15 the first layer is composed of thermoplastic polyolefin (TPO). In some embodiments, the second layer is composed of a polymer. In some embodiments, the second layer is composed of thermoplastic polyolefin (TPO). In some embodiments, the second layer includes fiberglass. In some embodiments, the first layer has a thickness of 25 mils to 100 mils. In some embodiments, the second layer has a thickness of 25 mils to 200 mils. In some embodiments, the first layer
20 includes a pattern printed on the first surface of the first layer. In some embodiments, the pattern is a depiction of solar cells. In some embodiments, the first layer is colored. In some embodiments, the first layer is black colored. In some embodiments, the second layer is colored. In some embodiments, the second layer is black colored.

In some embodiments, a method, comprising the steps of: obtaining a plurality of roofing modules, each of the roofing modules includes a first layer wherein the first layer includes a first surface, and a second surface opposite the first surface, wherein the first surface is textured, and a second layer, wherein the second layer is juxtaposed with the second surface of the first layer, wherein each of the roofing modules does not include a solar cell; obtaining a plurality of photovoltaic modules, each of the plurality of photovoltaic modules includes at least one solar cell, an encapsulant encapsulating the at least one solar cell, wherein the encapsulant of the photovoltaic module includes a first surface and a second surface opposite the first surface of the encapsulant of the photovoltaic module, a frontsheet, wherein the frontsheet includes a first surface, and a second surface opposite the first surface of the frontsheet, wherein the second surface of the frontsheet is juxtaposed with the first surface of the encapsulant, wherein the first surface of the frontsheet is textured, and a backsheet juxtaposed with the second surface of the encapsulant of the photovoltaic module; installing the plurality of photovoltaic modules on a roof deck of a structure; cutting at least one of the plurality of roofing modules to a size and shape; and installing the plurality of roofing modules on the roof deck proximate to the plurality of photovoltaic modules, wherein the at least one solar cell of at least one of the plurality of photovoltaic modules is electrically active, and wherein an appearance of the roofing modules aesthetically matches an appearance of the photovoltaic modules when viewed from a vantage point located at a ground level of the structure.

In some embodiments, each of the first layer and the second layer is composed of a polymer. In some embodiments, each of the first layer and the second layer is composed of thermoplastic polyolefin (TPO). In some embodiments, the first layer has a thickness of 25 mils to 100 mils, and wherein the second layer has a thickness of 25 mils to 200 mils. In some

embodiments, the first layer includes a pattern printed on the first surface of the first layer. In some embodiments, the pattern is a depiction of solar cells.

Brief Description of the Drawings

- 5 **FIG. 1** is a schematic view of an embodiment of a roofing module;
 FIG. 2 shows an embodiment of a roofing module;
 FIG. 3 is a schematic view of another embodiment of a roofing module;
 FIG. 4 is a schematic view of another embodiment of a roofing module;
 FIG. 5 shows an embodiment of a roofing module;
10 **FIG. 6** shows embodiments of a roofing system;
 FIG. 7 is a schematic view of another embodiment of a roofing module;
 FIG. 8 is a schematic view of another embodiment of a roofing module;
 FIG. 9 is a schematic view of another embodiment of a roofing module;
 FIG. 10 is a schematic view of another embodiment of a roofing module;
15 **FIG. 11** is a schematic view of another embodiment of a roofing module;
 FIGS. 12A to 12D show embodiments of a roofing module;
 FIG. 13 is a schematic view of another embodiment of a roofing module;
 FIG. 14 is a schematic view of another embodiment of a roofing module;
 FIG. 15 is a schematic view another embodiment of a photovoltaic module;
20 **FIGS. 16 and 17** show an embodiment of a roofing module;
 FIG. 18 shows a schematic view of an embodiment of a photovoltaic module;
 FIGS. 19A through 19C show embodiments of a textured release liner employed by the
photovoltaic module shown in **FIG. 18**;

FIG. 20 shows an embodiment of a solar cell employed by the photovoltaic module shown in **FIG. 18**;

FIGS. 21A through **21C** show embodiments of a photovoltaic module including the textured release liner shown in **FIG. 19A**;

5 **FIGS. 22A** through **22C** show embodiments of a photovoltaic module including the textured release liner shown in **FIG. 19B**;

FIGS. 23A through **23C** show embodiments of a photovoltaic module including the textured release liner shown in **FIG. 19C**;

FIGS. 24 and **25** show embodiments of release liners;

10 **FIG. 26** is a graph showing gloss versus embodiments of textured release liners; and

FIG. 27 illustrates an embodiment of a roofing system with roofing shingles.

Detailed Description

15 The present invention will be further explained with reference to the attached drawings, wherein like structures are referred to by like numerals throughout the several views. The drawings shown are not necessarily to scale, with emphasis instead generally being placed upon illustrating the principles of the present invention. Further, some features may be exaggerated to show details of particular components.

20 The figures constitute a part of this specification and include illustrative embodiments of the present invention and illustrate various objects and features thereof. Further, the figures are not necessarily to scale, some features may be exaggerated to show details of particular components. In addition, any measurements, specifications and the like shown in the figures are intended to be illustrative, and not restrictive. Therefore, specific structural and functional details

disclosed herein are not to be interpreted as limiting, but merely as a representative basis for teaching one skilled in the art to variously employ the present invention.

Among those benefits and improvements that have been disclosed, other objects and advantages of this invention will become apparent from the following description taken in conjunction with the accompanying figures. Detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely illustrative of the invention that may be embodied in various forms. In addition, each of the examples given in connection with the various embodiments of the invention which are intended to be illustrative, and not restrictive.

Throughout the specification and claims, the following terms take the meanings explicitly associated herein, unless the context clearly dictates otherwise. The phrases "in one embodiment" and "in some embodiments" as used herein do not necessarily refer to the same embodiment(s), though they may. Furthermore, the phrases "in another embodiment" and "in some other embodiments" as used herein do not necessarily refer to a different embodiment, although they may. Thus, as described below, various embodiments of the invention may be readily combined, without departing from the scope or spirit of the invention.

The term "based on" is not exclusive and allows for being based on additional factors not described, unless the context clearly dictates otherwise. In addition, throughout the specification, the meaning of "a," "an," and "the" include plural references. The meaning of "in" includes "in" and "on."

Referring to **FIGS. 1** through **2**, in some embodiments, a roofing module **10** includes at least one cell **12**, an encapsulant **14** encapsulating the at least one cell **12**, and a frontsheet **16** juxtaposed with the encapsulant **14**. In some embodiments, the frontsheet **16** is juxtaposed with a

first surface of the encapsulant **14**. As used herein, the terms “encapsulating” and “encapsulates” mean to partially or fully envelope or enclose, and with respect to certain embodiments of the roofing module **10**, the at least one cell **12** is fully enveloped by or enclosed within the encapsulant **14**, or partially enveloped by or enclosed within the encapsulant **14**. In some embodiments, the at least one cell **12** includes a plurality of cells **12**. In some embodiments, the encapsulant **14** encapsulates 50% to 99.9% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% to 99.9% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 60% to 99.9% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 65% to 99.9% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 70% to 99.9% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 75% to 99.9% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 80% to 99.9% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 85% to 99.9% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 90% to 99.9% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 95% to 99.9% of an exterior surface area of the at least one cell **12**.

In another embodiment, the encapsulant **14** encapsulates 50% to 95% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% to 95% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 60% to 95% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 65% to 95% of an exterior surface area of the at

least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 70% to 95% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 75% to 95% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 80% to 95% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 85% to 95% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 90% to 95% of an exterior surface area of the at least one cell **12**.

In another embodiment, the encapsulant **14** encapsulates 50% to 90% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% to 90% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 60% to 90% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 65% to 90% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 70% to 90% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 75% to 90% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 80% to 90% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 85% to 90% of an exterior surface area of the at least one cell **12**.

In another embodiment, the encapsulant **14** encapsulates 50% to 85% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% to 85% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 60% to 85% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 65% to 85% of an exterior surface area of the at least one cell **12**.

least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 70% to 85% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 75% to 85% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 80% to 85% of an exterior surface area of the at least one cell **12**.

In another embodiment, the encapsulant **14** encapsulates 50% to 80% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% to 80% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 60% to 80% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 65% to 80% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 70% to 80% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 75% to 80% of an exterior surface area of the at least one cell **12**.

In another embodiment, the encapsulant **14** encapsulates 50% to 75% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% to 75% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 60% to 75% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 65% to 75% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 70% to 75% of an exterior surface area of the at least one cell **12**.

In another embodiment, the encapsulant **14** encapsulates 50% to 70% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% to 70% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant

14 encapsulates 60% to 70% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 65% to 70% of an exterior surface area of the at least one cell **12**.

In another embodiment, the encapsulant **14** encapsulates 50% to 65% of an exterior surface
5 area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% to 65% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 60% to 65% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 50% to 60% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% to 60% of an
10 exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% to 60% of an exterior surface area of the at least one cell **12**.

In some embodiments, the encapsulant **14** encapsulates 50% of an exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 55% of the exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14**
15 encapsulates 60% of the exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 65% of the exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 70% of the exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 75% of the exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates
20 80% of the exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 85% of the exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 90% of the exterior surface area of the at least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 95% of the exterior surface area of the at

least one cell **12**. In another embodiment, the encapsulant **14** encapsulates 100% of the exterior surface area of the at least one cell **12**.

In some embodiments, the encapsulant **14** has a thickness of 0.5 mm to 4 mm. In another embodiment, the encapsulant **14** has a thickness of 0.5 mm to 3.5 mm. In another embodiment, the encapsulant **14** has a thickness of 0.5 mm to 3 mm. In another embodiment, the encapsulant **14** has a thickness of 0.5 mm to 2.5 mm. In another embodiment, the encapsulant **14** has a thickness of 0.5 mm to 2 mm. In another embodiment, the encapsulant **14** has a thickness of 0.5 mm to 1.5 mm. In another embodiment, the encapsulant **14** has a thickness of 0.5 mm to 1 mm.

In some embodiments, the encapsulant **14** has a thickness of 1 mm to 4 mm. In another embodiment, the encapsulant **14** has a thickness of 1 mm to 3.5 mm. In another embodiment, the encapsulant **14** has a thickness of 1 mm to 3 mm. In another embodiment, the encapsulant **14** has a thickness of 1 mm to 2.5 mm. In another embodiment, the encapsulant **14** has a thickness of 1 mm to 2 mm. In another embodiment, the encapsulant **14** has a thickness of 1 mm to 1.5 mm. In some embodiments, the encapsulant **14** has a thickness of 1.5 mm to 4 mm. In another embodiment, the encapsulant **14** has a thickness of 1.5 mm to 3.5 mm. In another embodiment, the encapsulant **14** has a thickness of 1.5 mm to 3 mm. In another embodiment, the encapsulant **14** has a thickness of 1.5 mm to 2.5 mm. In another embodiment, the encapsulant **14** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the encapsulant **14** has a thickness of 2 mm to 4 mm. In another embodiment, the encapsulant **14** has a thickness of 2 mm to 3.5 mm. In another embodiment, the encapsulant **14** has a thickness of 2 mm to 3 mm. In another embodiment, the encapsulant **14** has a thickness of 2 mm to 2.5 mm. In some embodiments, the encapsulant **14** has a thickness of 2.5 mm to 4 mm. In another embodiment, the encapsulant **14** has a thickness of 2.5 mm to 3.5 mm.

In another embodiment, the encapsulant **14** has a thickness of 2.5 mm to 3 mm. In some embodiments, the encapsulant **14** has a thickness of 3 mm to 4 mm. In another embodiment, the encapsulant **14** has a thickness of 3 mm to 3.5 mm. In some embodiments, the encapsulant **14** has a thickness of 3.5 mm to 4 mm.

5 In some embodiments, the encapsulant **14** has a thickness of 0.5 mm. In some embodiments, the encapsulant **14** has a thickness of 0.6 mm. In some embodiments, the encapsulant **14** has a thickness of 0.7 mm. In some embodiments, the encapsulant **14** has a thickness of 0.8 mm. In some embodiments, the encapsulant **14** has a thickness of 0.9 mm. In some embodiments, the encapsulant **14** has a thickness of 1 mm. In some embodiments, the encapsulant **14** has a thickness of 1.5 mm. In some embodiments, the encapsulant **14** has a thickness of 2 mm. In some embodiments, the encapsulant **14** has a thickness of 2.5 mm. In some embodiments, the encapsulant **14** has a thickness of 3 mm. In some embodiments, the encapsulant **14** has a thickness of 3.5 mm. In some embodiments, the encapsulant **14** has a thickness of 4 mm.

15 In some embodiments, a first layer **14a** of the encapsulant **14** has a thickness of 0.2 mm to 2 mm. In some embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.2 mm to 1.5 mm. In some embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.2 mm to 1 mm. In some embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.2 mm to 0.5 mm. In some embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.5 mm to 2 mm. In some embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.5 mm to 1.5 mm. In some embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.5 mm to 1 mm. In some embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 1 mm to 2 mm. In some embodiments, the first layer **14a** of the encapsulant **14** has

20

a thickness of 1 mm to 1.5 mm. In some embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.2 mm. In some embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.3 mm. In some
5 embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.4 mm. In some
embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.45 mm. In some
embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 0.5 mm. In some
embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 1 mm. In some
embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 1.5 mm. In some
10 embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 2 mm. In some
embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 2.5 mm. In some
embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 3 mm. In some
embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 3.5 mm. In some
embodiments, the first layer **14a** of the encapsulant **14** has a thickness of 4 mm.

15 In some embodiments, a second layer **14b** of the encapsulant **14** has a thickness of 0.2 mm
to 2 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 0.2
mm to 1.5 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness
of 0.2 mm to 1 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a
thickness of 0.2 mm to 0.5 mm. In some embodiments, the second layer **14b** of the encapsulant
20 **14** has a thickness of 0.5 mm to 2 mm. In some embodiments, the second layer **14b** of the
encapsulant **14** has a thickness of 0.5 mm to 1.5 mm. In some embodiments, the second layer **14b**
of the encapsulant **14** has a thickness of 0.5 mm to 1 mm. In some embodiments, the second layer
14b of the encapsulant **14** has a thickness of 1 mm to 2 mm. In some embodiments, the second

layer **14b** of the encapsulant **14** has a thickness of 1 mm to 1.5 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 0.2 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 0.3 mm.

5 In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 0.4 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 0.45 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 0.5 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 1 mm. In some
10 embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 1.5 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 2 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 2.5 mm. In some embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 3 mm. In some
embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 3.5 mm. In some
embodiments, the second layer **14b** of the encapsulant **14** has a thickness of 4 mm.

15 In some embodiments, the thickness of the first layer **14a** is equal to the thickness of the second layer **14b**. In another embodiment, the thickness of the first layer **14a** is different from the thickness of the second layer **14b**.

In some embodiments, the encapsulant **14** may be made from polyolefins, ethyl vinyl acetates, ionomers, silicones, poly vinyl butyral, epoxies, polyurethanes, or combinations/hybrids
20 thereof. In some embodiments, the encapsulant **14** is made from thermosetting polyolefin.

In some embodiments, the roofing module **10** includes a first end **18**, a second end **20** opposite the first end **18**, a first surface **19** extending from the first end **18** to the second end **20**, and a second surface **21** opposite the first surface **19** and extending from the first end **18** to the

second end **20**. In some embodiments, the first surface **19** is an upper, sun facing-side surface of the roofing module **10**, and the second surface **21** is a lower surface configured to face a roof deck on which the roofing module **10** is installed.

In some embodiments, the at least one cell **12** includes a plurality of the cells **12**. In some
5 embodiments, the at least one cell **12** is a solar cell. In some embodiments, the solar cell is electrically inactive (i.e., a “dummy” solar cell). In some embodiments, the plurality of cells **12** is arranged in one row (i.e., one reveal). In another embodiment, the plurality of cells **12** is arranged in two rows (i.e., two reveals). In another embodiment, the plurality of cells **12** is arranged in three rows (i.e., three reveals). In other embodiments, the plurality of cells **12** is arranged in more than
10 three rows.

In some embodiments, the frontsheet **16** includes a glass layer **22** and a polymer layer **24** attached to a first surface of the glass layer **22**. In some embodiments, the frontsheet **16** is juxtaposed with the first layer **14a** of the encapsulant **14**. In some embodiments, each of the encapsulant **14**, the glass layer **22**, and the polymer layer **24** is transparent. In some embodiments,
15 the polymer layer **24** is attached to the glass layer **22** by an first adhesive layer **26**. In some embodiments, the first adhesive layer **26** may include polyvinyl butyrate, acrylic, silicone, or polycarbonate. In another embodiment, the first adhesive layer **26** may include pressure sensitive adhesives. In another embodiment, the polymer layer **24** is attached to the glass layer **22** by thermal bonding. In another embodiment, the frontsheet **16** includes at least one of the glass layer
20 **22** or the polymer layer **24**. In some embodiments, the first adhesive layer **26** is transparent. As used herein, the term “transparent” means having a solar weighted transmittance of 80% or greater, and with respect to certain embodiments of the roofing module **10**, a transparent layer of the

roofing module has a solar weighted transmittance of 80% or greater. In another embodiment, the frontsheet **16** does not include the glass layer **22**.

In some embodiments, the glass layer **22** has a thickness of 1 mm to 4 mm. In some embodiments, the glass layer **22** has a thickness of 1 mm to 3.5 mm. In some embodiments, the glass layer **22** has a thickness of 1 mm to 3 mm. In some embodiments, the glass layer **22** has a thickness of 1 mm to 2.5 mm. In some embodiments, the glass layer **22** has a thickness of 1 mm to 2 mm. In some embodiments, the glass layer **22** has a thickness of 1 mm to 1.5 mm. In some embodiments, the glass layer **22** has a thickness of 1.5 mm to 4 mm. In some embodiments, the glass layer **22** has a thickness of 1.5 mm to 3.5 mm. In some embodiments, the glass layer **22** has a thickness of 1.5 mm to 3 mm. In some embodiments, the glass layer **22** has a thickness of 1 mm to 2.5 mm. In some embodiments, the glass layer **22** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the glass layer **22** has a thickness of 2 mm to 4 mm. In some embodiments, the glass layer **22** has a thickness of 2 mm to 3.5 mm. In some embodiments, the glass layer **22** has a thickness of 2 mm to 3 mm. In some embodiments, the glass layer **22** has a thickness of 2 mm to 2.5 mm. In some embodiments, the glass layer **22** has a thickness of 2.5 mm to 4 mm. In some embodiments, the glass layer **22** has a thickness of 2.5 mm to 3.5 mm. In some embodiments, the glass layer **22** has a thickness of 2.5 mm to 3 mm. In some embodiments, the glass layer **22** has a thickness of 3 mm to 4 mm. In some embodiments, the glass layer **22** has a thickness of 3 mm to 3.5 mm. In some embodiments, the glass layer **22** has a thickness of 3.5 mm to 4 mm.

In some embodiments, the glass layer **22** has a thickness of 1 mm. In some embodiments, the glass layer **22** has a thickness of 1.5 mm. In some embodiments, the glass layer **22** has a thickness of 2 mm. In some embodiments, the glass layer **22** has a thickness of 2.5 mm. In some

embodiments, the glass layer **22** has a thickness of 3 mm. In some embodiments, the glass layer **22** has a thickness of 3.5 mm. In some embodiments, the glass layer **22** has a thickness of 4 mm.

In some embodiments, the first adhesive layer **26** includes thermosetting polyolefin, thermosetting polyolefin encapsulant material, ethylene-vinyl acetate (EVA), EVA encapsulants,
5 thermoplastic olefin, thermoplastic polyolefin (TPO) or hybrids/combinations thereof.

In some embodiments, the first adhesive layer **26** has a thickness of 0.2 mm to 2 mm. In some embodiments, the first adhesive layer **26** has a thickness of 0.2 mm to 1.5 mm. In some embodiments, the first adhesive layer **26** has a thickness of 0.2 mm to 1 mm. In some
10 embodiments, the first adhesive layer **26** has a thickness of 0.2 mm to 0.5 mm. In some embodiments, the first adhesive layer **26** has a thickness of 0.5 mm to 2 mm. In some embodiments, the first adhesive layer **26** has a thickness of 0.5 mm to 1.5 mm. In some embodiments, the first adhesive layer **26** has a thickness of 0.5 mm to 1 mm. In some
15 embodiments, the first adhesive layer **26** has a thickness of 1 mm to 2 mm. In some embodiments, the first adhesive layer **26** has a thickness of 1 mm to 1.5 mm. In some embodiments, the first adhesive layer **26** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the first adhesive layer **26** has a thickness of 0.2 mm. In some embodiments, the first adhesive layer **26** has a thickness of 0.3 mm. In some embodiments, the first adhesive layer **26** has a thickness of 0.4 mm. In some embodiments, the first adhesive layer **26** has a thickness of 0.45 mm. In some embodiments, the first adhesive layer **26** has a thickness
20 of 0.5 mm. In some embodiments, the first adhesive layer **26** has a thickness of 1 mm. In some embodiments, the first adhesive layer **26** has a thickness of 1.5 mm. In some embodiments, the first adhesive layer **26** has a thickness of 2 mm. In some embodiments, the first adhesive layer **26** has a thickness of 2.5 mm. In some embodiments, the first adhesive layer **26** has a thickness of 3

mm. In some embodiments, the first adhesive layer **26** has a thickness of 3.5 mm. In some embodiments, the first adhesive layer **26** has a thickness of 4 mm.

In another embodiment, the first adhesive layer **26** has a thickness of 1 μm to 900 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 900 μm . In some
5 embodiments, the first adhesive layer **26** has a thickness of 1 μm to 850 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 800 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 750 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 700 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 650 μm . In some embodiments, the first adhesive layer **26** has a thickness
10 of 1 μm to 600 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 550 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 500 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 450 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 400 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 350 μm . In some embodiments, the first
15 adhesive layer **26** has a thickness of 1 μm to 300 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 250 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 200 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 150 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 100 μm . In some embodiments, the first adhesive layer **26** has a thickness of 1 μm to 50 μm .

20 In some embodiments, the first adhesive layer **26** has a thickness of 50 μm to 900 μm . In some embodiments, the first adhesive layer **26** has a thickness of 50 μm to 850 μm . In some embodiments, the first adhesive layer **26** has a thickness of 50 μm to 800 μm . In some embodiments, the first adhesive layer **26** has a thickness of 50 μm to 750 μm . In some

embodiments, the first adhesive layer **26** has a thickness of 50 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm to 650 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm to 600 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm to 550 μm . In some
5 embodiments, the first adhesive layer **26** has a thickness of 50 μm to 500 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm to 450 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm to 400 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm to 350 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm to 300 μm . In some
10 embodiments, the first adhesive layer **26** has a thickness of 50 μm to 250 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm to 200 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm to 150 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm to 100 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 100 μm to 900 μm . In
15 some embodiments, the first adhesive layer **26** has a thickness of 100 μm to 850 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 650 μm . In some
20 embodiments, the first adhesive layer **26** has a thickness of 100 μm to 600 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 550 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 500 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 450 μm . In some

embodiments, the first adhesive layer **26** has a thickness of 100 μm to 400 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 350 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 300 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 250 μm . In some
5 embodiments, the first adhesive layer **26** has a thickness of 100 μm to 200 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 100 μm to 150 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 150 μm to 900 μm . In
some embodiments, the first adhesive layer **26** has a thickness of 150 μm to 850 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 150 μm to 800 μm . In some
10 embodiments, the first adhesive layer **26** has a thickness of 150 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 150 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 150 μm to 650 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 150 μm to 600 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 150 μm to 550 μm . In some
15 embodiments, the first adhesive layer **26** has a thickness of 150 μm to 500 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 150 μm to 450 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 150 μm to 400 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 150 μm to 350 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 150 μm to 300 μm . In some
20 embodiments, the first adhesive layer **26** has a thickness of 150 μm to 250 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 150 μm to 200 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 200 μm to 900 μm . In
some embodiments, the first adhesive layer **26** has a thickness of 200 μm to 850 μm . In some

embodiments, the first adhesive layer **26** has a thickness of 200 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 200 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 200 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 200 μm to 650 μm . In some
5 embodiments, the first adhesive layer **26** has a thickness of 200 μm to 600 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 200 μm to 550 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 200 μm to 500 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 200 μm to 450 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 200 μm to 400 μm . In some
10 embodiments, the first adhesive layer **26** has a thickness of 200 μm to 350 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 200 μm to 300 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 200 μm to 250 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 250 μm to 900 μm . In
some embodiments, the first adhesive layer **26** has a thickness of 250 μm to 850 μm . In some
15 embodiments, the first adhesive layer **26** has a thickness of 250 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 250 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 250 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 250 μm to 650 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 250 μm to 600 μm . In some
20 embodiments, the first adhesive layer **26** has a thickness of 250 μm to 550 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 250 μm to 500 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 250 μm to 450 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 250 μm to 400 μm . In some

embodiments, the first adhesive layer **26** has a thickness of 250 μm to 350 μm . In some embodiments, the first adhesive layer **26** has a thickness of 250 μm to 300 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 300 μm to 900 μm . In some embodiments, the first adhesive layer **26** has a thickness of 300 μm to 850 μm . In some
5 embodiments, the first adhesive layer **26** has a thickness of 300 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 300 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 300 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 300 μm to 650 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 300 μm to 600 μm . In some
10 embodiments, the first adhesive layer **26** has a thickness of 300 μm to 550 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 300 μm to 500 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 300 μm to 450 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 300 μm to 400 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 300 μm to 350 μm .

15 In some embodiments, the first adhesive layer **26** has a thickness of 350 μm to 900 μm . In
some embodiments, the first adhesive layer **26** has a thickness of 350 μm to 850 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 350 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 350 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 350 μm to 700 μm . In some
20 embodiments, the first adhesive layer **26** has a thickness of 350 μm to 650 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 350 μm to 600 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 350 μm to 550 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 350 μm to 500 μm . In some

embodiments, the first adhesive layer **26** has a thickness of 350 μm to 450 μm . In some embodiments, the first adhesive layer **26** has a thickness of 350 μm to 400 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 400 μm to 900 μm . In some embodiments, the first adhesive layer **26** has a thickness of 400 μm to 850 μm . In some
5 embodiments, the first adhesive layer **26** has a thickness of 400 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 400 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 400 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 400 μm to 650 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 400 μm to 600 μm . In some
10 embodiments, the first adhesive layer **26** has a thickness of 400 μm to 550 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 400 μm to 500 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 400 μm to 450 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 450 μm to 900 μm . In
some embodiments, the first adhesive layer **26** has a thickness of 450 μm to 850 μm . In some
15 embodiments, the first adhesive layer **26** has a thickness of 450 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 450 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 450 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 450 μm to 650 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 450 μm to 600 μm . In some
20 embodiments, the first adhesive layer **26** has a thickness of 450 μm to 550 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 450 μm to 500 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 500 μm to 900 μm . In
some embodiments, the first adhesive layer **26** has a thickness of 500 μm to 850 μm . In some

embodiments, the first adhesive layer **26** has a thickness of 500 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 500 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 500 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 500 μm to 650 μm . In some
5 embodiments, the first adhesive layer **26** has a thickness of 500 μm to 600 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 500 μm to 550 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 550 μm to 900 μm . In
some embodiments, the first adhesive layer **26** has a thickness of 550 μm to 850 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 550 μm to 800 μm . In some
10 embodiments, the first adhesive layer **26** has a thickness of 550 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 550 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 550 μm to 650 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 550 μm to 600 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 600 μm to 900 μm . In
15 some embodiments, the first adhesive layer **26** has a thickness of 600 μm to 850 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 600 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 600 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 600 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 600 μm to 650 μm .

20 In some embodiments, the first adhesive layer **26** has a thickness of 650 μm to 900 μm . In
some embodiments, the first adhesive layer **26** has a thickness of 650 μm to 850 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 650 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 650 μm to 750 μm . In some

embodiments, the first adhesive layer **26** has a thickness of 650 μm to 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 700 μm to 900 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 700 μm to 850 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 700 μm to 800 μm . In some
5 embodiments, the first adhesive layer **26** has a thickness of 700 μm to 750 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 750 μm to 900 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 750 μm to 850 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 750 μm to 800 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 800 μm to 900 μm . In some
10 embodiments, the first adhesive layer **26** has a thickness of 800 μm to 850 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 850 μm to 900 μm .

In some embodiments, the first adhesive layer **26** has a thickness of 1 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 50 μm . In some embodiments, the first
adhesive layer **26** has a thickness of 100 μm . In some embodiments, the first adhesive layer **26**
15 has a thickness of 1 μm . In some embodiments, the first adhesive layer **26** has a thickness of 150
 μm . In some embodiments, the first adhesive layer **26** has a thickness of 200 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 250 μm . In some embodiments, the
first adhesive layer **26** has a thickness of 300 μm . In some embodiments, the first adhesive layer
26 has a thickness of 350 μm . In some embodiments, the first adhesive layer **26** has a thickness
20 of 400 μm . In some embodiments, the first adhesive layer **26** has a thickness of 450 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 500 μm . In some embodiments, the
first adhesive layer **26** has a thickness of 550 μm . In some embodiments, the first adhesive layer
26 has a thickness of 600 μm . In some embodiments, the first adhesive layer **26** has a thickness

of 650 μm . In some embodiments, the first adhesive layer **26** has a thickness of 700 μm . In some
embodiments, the first adhesive layer **26** has a thickness of 750 μm . In some embodiments, the
first adhesive layer **26** has a thickness of 800 μm . In some embodiments, the first adhesive layer
26 has a thickness of 850 μm . In some embodiments, the first adhesive layer **26** has a thickness
5 of 900 μm .

In some embodiments, the polymer layer **24** includes a fluoropolymer. In certain
embodiments, the fluoropolymer may be ethylene tetrafluoroethylene (ETFE), fluoropolymer is
polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), and
tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), polyvinyl
10 fluoride (PVF), or blends thereof. In some embodiments, the frontsheet includes fluoropolymers,
acrylics, polyesters, silicones, polycarbonates, or combinations thereof. In other embodiments, the
polymer layer **24** includes polyethylene terephthalate (PET), polyethylene naphthalate (PEN),
polyetheretherketone (PEEK), polyaryletherketone (PAEK), polyarylate (PAR), polyetherimide
(PEI), polyarylsulfone (PAS), polyethersulfone (PES), polyamideimide (PAI), polyphenylsulfone
15 (PPSU), polyolefin, cyclic olefin copolymers (CPCs), or polyimide. In some embodiments, the
polymer layer **24** includes a crosslinked polymeric material. In some embodiments, 50% to 99%
of the polymer chains of the polymeric material are crosslinked.

In some embodiments, the polymer layer **24** has a thickness of 0.01 mm to 0.5 mm. In
some embodiments, the polymer layer **24** has a thickness of 0.01 mm to 0.45 mm. In some
20 embodiments, the polymer layer **24** has a thickness of 0.01 mm to 0.4 mm. In some embodiments,
the polymer layer **24** has a thickness of 0.01 mm to 0.35 mm. In some embodiments, the polymer
layer **24** has a thickness of 0.01 mm to 0.3 mm. In some embodiments, the polymer layer **24** has
a thickness of 0.01 mm to 0.25 mm. In some embodiments, the polymer layer **24** has a thickness

of 0.01 mm to 0.2 mm. In some embodiments, the polymer layer **24** has a thickness of 0.01 mm to 0.15 mm. In some embodiments, the polymer layer **24** has a thickness of 0.01 mm to 0.1 mm. In some embodiments, the polymer layer **24** has a thickness of 0.01 mm to 0.05 mm.

In some embodiments, the polymer layer **24** has a thickness of 0.05 mm to 0.5 mm. In some embodiments, the polymer layer **24** has a thickness of 0.05 mm to 0.45 mm. In some embodiments, the polymer layer **24** has a thickness of 0.05 mm to 0.4 mm. In some embodiments, the polymer layer **24** has a thickness of 0.05 mm to 0.35 mm. In some embodiments, the polymer layer **24** has a thickness of 0.05 mm to 0.3 mm. In some embodiments, the polymer layer **24** has a thickness of 0.05 mm to 0.25 mm. In some embodiments, the polymer layer **24** has a thickness of 0.05 mm to 0.2 mm. In some embodiments, the polymer layer **24** has a thickness of 0.05 mm to 0.15 mm. In some embodiments, the polymer layer **24** has a thickness of 0.05 mm to 0.1 mm.

In some embodiments, the polymer layer **24** has a thickness of 0.1 mm to 0.5 mm. In some embodiments, the polymer layer **24** has a thickness of 0.1 mm to 0.45 mm. In some embodiments, the polymer layer **24** has a thickness of 0.1 mm to 0.4 mm. In some embodiments, the polymer layer **24** has a thickness of 0.1 mm to 0.35 mm. In some embodiments, the polymer layer **24** has a thickness of 0.1 mm to 0.3 mm. In some embodiments, the polymer layer **24** has a thickness of 0.1 mm to 0.25 mm. In some embodiments, the polymer layer **24** has a thickness of 0.1 mm to 0.2 mm. In some embodiments, the polymer layer **24** has a thickness of 0.1 mm to 0.15 mm. In some embodiments, the polymer layer **24** has a thickness of 0.15 mm to 0.5 mm. In some embodiments, the polymer layer **24** has a thickness of 0.15 mm to 0.45 mm. In some embodiments, the polymer layer **24** has a thickness of 0.15 mm to 0.4 mm. In some embodiments, the polymer layer **24** has a thickness of 0.15 mm to 0.35 mm. In some embodiments, the polymer layer **24** has a thickness

of 0.15 mm to 0.3 mm. In some embodiments, the polymer layer **24** has a thickness of 0.15 mm to 0.25 mm. In some embodiments, the polymer layer **24** has a thickness of 0.15 mm to 0.2 mm.

In some embodiments, the polymer layer **24** has a thickness of 0.2 mm to 0.5 mm. In some embodiments, the polymer layer **24** has a thickness of 0.2 mm to 0.45 mm. In some embodiments, the polymer layer **24** has a thickness of 0.2 mm to 0.4 mm. In some embodiments, the polymer layer **24** has a thickness of 0.2 mm to 0.35 mm. In some embodiments, the polymer layer **24** has a thickness of 0.2 mm to 0.3 mm. In some embodiments, the polymer layer **24** has a thickness of 0.2 mm to 0.25 mm. In some embodiments, the polymer layer **24** has a thickness of 0.25 mm to 0.5 mm. In some embodiments, the polymer layer **24** has a thickness of 0.25 mm to 0.45 mm. In some embodiments, the polymer layer **24** has a thickness of 0.25 mm to 0.4 mm. In some embodiments, the polymer layer **24** has a thickness of 0.25 mm to 0.35 mm. In some embodiments, the polymer layer **24** has a thickness of 0.25 mm to 0.3 mm.

In some embodiments, the polymer layer **24** has a thickness of 0.3 mm to 0.5 mm. In some embodiments, the polymer layer **24** has a thickness of 0.3 mm to 0.45 mm. In some embodiments, the polymer layer **24** has a thickness of 0.3 mm to 0.4 mm. In some embodiments, the polymer layer **24** has a thickness of 0.3 mm to 0.35 mm. In some embodiments, the polymer layer **24** has a thickness of 0.35 mm to 0.5 mm. In some embodiments, the polymer layer **24** has a thickness of 0.35 mm to 0.45 mm. In some embodiments, the polymer layer **24** has a thickness of 0.35 mm to 0.4 mm. In some embodiments, the polymer layer **24** has a thickness of 0.4 mm to 0.5 mm. In some embodiments, the polymer layer **24** has a thickness of 0.4 mm to 0.45 mm. In some embodiments, the polymer layer **24** has a thickness of 0.45 mm to 0.5 mm.

In some embodiments, the polymer layer **24** has a thickness of 0.01 mm. In some embodiments, the polymer layer **24** has a thickness of 0.05 mm. In some embodiments, the

polymer layer **24** has a thickness of 0.1 mm. In some embodiments, the polymer layer **24** has a thickness of 0.15 mm. In some embodiments, the polymer layer **24** has a thickness of 0.2 mm. In some embodiments, the polymer layer **24** has a thickness of 0.25 mm. In some embodiments, the polymer layer **24** has a thickness of 0.3 mm. In some embodiments, the polymer layer **24** has a thickness of 0.35 mm. In some embodiments, the polymer layer **24** has a thickness of 0.4 mm. In some embodiments, the polymer layer **24** has a thickness of 0.45 mm. In some embodiments, the polymer layer **24** has a thickness of 0.5 mm.

In some embodiments, a backsheet **28** is juxtaposed with a second layer **14b** of the encapsulant **14**. In some embodiments, the backsheet **28** includes a first layer **30** and a second layer **32**. In some embodiments, the first layer **30** is juxtaposed with the second layer **14b** of the encapsulant **14**. In some embodiments, the second layer **32** is juxtaposed with the first layer **30**.

In some embodiments, the first layer **30** of the backsheet **28** includes a polymeric material. In some embodiments, the first layer **30** of the backsheet **28** includes polyethylene terephthalate ("PET"). In another embodiment, the first layer **30** of the backsheet **28** includes ethylene tetrafluoroethylene ("ETFE"). In some embodiments, the first layer **30** of the backsheet **28** includes an acrylic such as polymethyl methacrylate ("PMMA"). In some embodiments, the first layer **30** of the backsheet **28** includes thermoplastic polyolefin (TPO). In some embodiments, the first layer **30** of the backsheet **28** includes a single ply TPO roofing membrane. In other embodiments, non-limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is incorporated by reference herein in its entirety. In another embodiment, the first layer **30** of the backsheet **28** includes polyvinyl chloride. In some embodiments, the first layer **30** of the backsheet **28** includes ethylene propylene diene monomer (EPDM) rubber. In some embodiments, the first layer **30** of the backsheet **28** includes a flame

retardant additive. In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof.

In some embodiments, the first layer **30** has a thickness of 0.2 mm to 0.5 mm. In another
5 embodiment, the first layer **30** has a thickness of 0.2 mm to 0.4 mm. In another embodiment, the first layer **30** has a thickness of 0.2 mm to 0.3 mm. In some embodiments, the first layer **30** has a thickness of 0.3 mm to 0.5 mm. In another embodiment, the first layer **30** has a thickness of 0.3 mm to 0.4 mm. In some embodiments, the first layer **30** has a thickness of 0.4 mm to 0.5 mm. In
10 some embodiments, the first layer **30** has a thickness of 0.2 mm. In some embodiments, the first layer **30** has a thickness of 0.3 mm. In some embodiments, the first layer **30** has a thickness of 0.4 mm. In some embodiments, the first layer **30** has a thickness of 0.5 mm.

In some embodiments, the second layer **32** of the backsheet **28** includes a polymeric material. In some embodiments, the second layer **32** of the backsheet **28** includes thermoplastic polyolefin (TPO). In some embodiments, the second layer **32** of the backsheet **28** includes a single
15 ply TPO roofing membrane. In other embodiments, non-limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is incorporated by reference herein in its entirety. In another embodiment, the second layer **32** of the backsheet **28** includes polyethylene terephthalate ("PET"). In another embodiment, the second layer **32** includes styrene acrylic copolymer. In another embodiment, the second layer **32** of the backsheet **28** includes
20 ethylene tetrafluoroethylene ("ETFE"). In some embodiments, the second layer **32** of the backsheet **28** includes an acrylic such as polymethyl methacrylate ("PMMA"). In another embodiment, the second layer **32** of the backsheet **28** includes polyvinyl chloride. In some embodiments, the second layer **32** of the backsheet **28** includes ethylene propylene diene monomer

(EPDM) rubber. In some embodiments, the second layer **32** of the backsheet **28** includes a flame retardant additive. In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof.

5 In some embodiments, the second layer **32** has a thickness of 1 mm to 5 mm. In some embodiments, the second layer **32** has a thickness of 1 mm to 4 mm. In some embodiments, the second layer **32** has a thickness of 1 mm to 3 mm. In some embodiments, the second layer **32** has a thickness of 1 mm to 2 mm. In some embodiments, the second layer **32** has a thickness of 2 mm to 5 mm. In some embodiments, the second layer **32** has a thickness of 2 mm to 4 mm. In some
10 embodiments, the second layer **32** has a thickness of 2 mm to 3 mm. In some embodiments, the second layer **32** has a thickness of 3 mm to 5 mm. In some embodiments, the second layer **32** has a thickness of 3 mm to 4 mm. In some embodiments, the second layer **32** has a thickness of 4 mm to 5 mm. In some embodiments, the second layer **32** has a thickness of 1 mm. In some
15 embodiments, the second layer **32** has a thickness of 2 mm. In some embodiments, the second layer **32** has a thickness of 3 mm. In some embodiments, the second layer **32** has a thickness of 4 mm. In some embodiments, the second layer **32** has a thickness of 5 mm.

 In some embodiments, the first layer **30** is attached to the second layer **32** by a second adhesive layer **34**. In some embodiments, the second adhesive layer **34** may include polyvinyl butyrate, acrylic, silicone, or polycarbonate. In another embodiment, the first adhesive layer **34**
20 may include pressure sensitive adhesives.

 In some embodiments, the second adhesive layer **34** includes thermosetting polyolefin, thermosetting polyolefin encapsulant material, thermosetting ethylene-vinyl acetate (EVA), EVA

encapsulants, thermoplastic olefin, thermoplastic polyolefin (TPO) or hybrids/combinations thereof.

In some embodiments, the second adhesive layer **34** has a thickness of 0.2 mm to 2 mm.

In some embodiments, the second adhesive layer **34** has a thickness of 0.2 mm to 1.5 mm. In some

5 embodiments, the second adhesive layer **34** has a thickness of 0.2 mm to 1 mm. In some

embodiments, the second adhesive layer **34** has a thickness of 0.2 mm to 0.5 mm. In some

embodiments, the second adhesive layer **34** has a thickness of 0.5 mm to 2 mm. In some

embodiments, the second adhesive layer **34** has a thickness of 0.5 mm to 1.5 mm. In some

embodiments, the second adhesive layer **34** has a thickness of 0.5 mm to 1 mm. In some

10 embodiments, the second adhesive layer **34** has a thickness of 1 mm to 2 mm. In some

embodiments, the second adhesive layer **34** has a thickness of 1 mm to 1.5 mm. In some

embodiments, the second adhesive layer **34** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the second adhesive layer **34** has a thickness of 0.2 mm. In some

embodiments, the second adhesive layer **34** has a thickness of 0.3 mm. In some embodiments, the

15 second adhesive layer **34** has a thickness of 0.4 mm. In some embodiments, the second adhesive

layer **34** has a thickness of 0.45 mm. In some embodiments, the second adhesive layer **34** has a

thickness of 0.5 mm. In some embodiments, the second adhesive layer **34** has a thickness of 1

mm. In some embodiments, the second adhesive layer **34** has a thickness of 1.5 mm. In some

embodiments, the second adhesive layer **34** has a thickness of 2 mm. In some embodiments, the

20 second adhesive layer **34** has a thickness of 2.5 mm. In some embodiments, the second adhesive

layer **34** has a thickness of 3 mm. In some embodiments, the second adhesive layer **34** has a

thickness of 3.5 mm. In some embodiments, the second adhesive layer **34** has a thickness of 4

mm.

In another embodiment, the second adhesive layer **34** has a thickness of 1 μm to 900 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 1 μm to 900 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 850 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 800 μm . In some
5 embodiments, the second adhesive layer **34** has a thickness of 1 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 650 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 600 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 550 μm . In some
10 embodiments, the second adhesive layer **34** has a thickness of 1 μm to 500 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 450 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 400 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 350 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 300 μm . In some
15 embodiments, the second adhesive layer **34** has a thickness of 1 μm to 250 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 200 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 150 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 100 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 1 μm to 50 μm .

20 In some embodiments, the second adhesive layer **34** has a thickness of 50 μm to 900 μm .
In some embodiments, the second adhesive layer **34** has a thickness of 50 μm to 850 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 800 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 750 μm . In some

embodiments, the second adhesive layer **34** has a thickness of 50 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 650 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 600 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 550 μm . In some
5 embodiments, the second adhesive layer **34** has a thickness of 50 μm to 500 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 450 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 400 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 350 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 300 μm . In some
10 embodiments, the second adhesive layer **34** has a thickness of 50 μm to 250 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 200 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 150 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm to 100 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 100 μm to 900 μm .
15 In some embodiments, the second adhesive layer **34** has a thickness of 100 μm to 850 μm . In
some embodiments, the second adhesive layer **34** has a thickness of 100 μm to 800 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 100 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 100 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 100 μm to 650 μm . In some
20 embodiments, the second adhesive layer **34** has a thickness of 100 μm to 600 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 100 μm to 550 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 100 μm to 500 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 100 μm to 450 μm . In some

embodiments, the second adhesive layer **34** has a thickness of 100 μm to 400 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 100 μm to 350 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 100 μm to 300 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 100 μm to 250 μm . In some
5 embodiments, the second adhesive layer **34** has a thickness of 100 μm to 200 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 100 μm to 150 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 150 μm to 900 μm .
In some embodiments, the second adhesive layer **34** has a thickness of 150 μm to 850 μm . In
some embodiments, the second adhesive layer **34** has a thickness of 150 μm to 800 μm . In some
10 embodiments, the second adhesive layer **34** has a thickness of 150 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 150 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 150 μm to 650 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 150 μm to 600 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 150 μm to 550 μm . In some
15 embodiments, the second adhesive layer **34** has a thickness of 150 μm to 500 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 150 μm to 450 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 150 μm to 400 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 150 μm to 350 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 150 μm to 300 μm . In some
20 embodiments, the second adhesive layer **34** has a thickness of 150 μm to 250 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 150 μm to 200 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 200 μm to 900 μm .
In some embodiments, the second adhesive layer **34** has a thickness of 200 μm to 850 μm . In

some embodiments, the second adhesive layer **34** has a thickness of 200 μm to 800 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 200 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 200 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 200 μm to 650 μm . In some
5 embodiments, the second adhesive layer **34** has a thickness of 200 μm to 600 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 200 μm to 550 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 200 μm to 500 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 200 μm to 450 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 200 μm to 400 μm . In some
10 embodiments, the second adhesive layer **34** has a thickness of 200 μm to 350 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 200 μm to 300 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 200 μm to 250 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 250 μm to 900 μm .
In some embodiments, the second adhesive layer **34** has a thickness of 250 μm to 850 μm . In
15 some embodiments, the second adhesive layer **34** has a thickness of 250 μm to 800 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 250 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 250 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 250 μm to 650 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 250 μm to 600 μm . In some
20 embodiments, the second adhesive layer **34** has a thickness of 250 μm to 550 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 250 μm to 500 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 250 μm to 450 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 250 μm to 400 μm . In some

embodiments, the second adhesive layer **34** has a thickness of 250 μm to 350 μm . In some embodiments, the second adhesive layer **34** has a thickness of 250 μm to 300 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 900 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 850 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 800 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 750 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 700 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 650 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 600 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 550 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 500 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 450 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 400 μm . In some embodiments, the second adhesive layer **34** has a thickness of 300 μm to 350 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 350 μm to 900 μm . In some embodiments, the second adhesive layer **34** has a thickness of 350 μm to 850 μm . In some embodiments, the second adhesive layer **34** has a thickness of 350 μm to 800 μm . In some embodiments, the second adhesive layer **34** has a thickness of 350 μm to 750 μm . In some embodiments, the second adhesive layer **34** has a thickness of 350 μm to 700 μm . In some embodiments, the second adhesive layer **34** has a thickness of 350 μm to 650 μm . In some embodiments, the second adhesive layer **34** has a thickness of 350 μm to 600 μm . In some embodiments, the second adhesive layer **34** has a thickness of 350 μm to 550 μm . In some embodiments, the second adhesive layer **34** has a thickness of 350 μm to 500 μm . In some

embodiments, the second adhesive layer **34** has a thickness of 350 μm to 450 μm . In some embodiments, the second adhesive layer **34** has a thickness of 350 μm to 400 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 400 μm to 900 μm . In some embodiments, the second adhesive layer **34** has a thickness of 400 μm to 850 μm . In
5 some embodiments, the second adhesive layer **34** has a thickness of 400 μm to 800 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 400 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 400 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 400 μm to 650 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 400 μm to 600 μm . In some
10 embodiments, the second adhesive layer **34** has a thickness of 400 μm to 550 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 400 μm to 500 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 400 μm to 450 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 450 μm to 900 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 450 μm to 850 μm . In
15 some embodiments, the second adhesive layer **34** has a thickness of 450 μm to 800 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 450 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 450 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 450 μm to 650 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 450 μm to 600 μm . In some
20 embodiments, the second adhesive layer **34** has a thickness of 450 μm to 550 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 450 μm to 500 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 500 μm to 900 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 500 μm to 850 μm . In

some embodiments, the second adhesive layer **34** has a thickness of 500 μm to 800 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 500 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 500 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 500 μm to 650 μm . In some
5 embodiments, the second adhesive layer **34** has a thickness of 500 μm to 600 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 500 μm to 550 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 550 μm to 900 μm .
In some embodiments, the second adhesive layer **34** has a thickness of 550 μm to 850 μm . In
some embodiments, the second adhesive layer **34** has a thickness of 550 μm to 800 μm . In some
10 embodiments, the second adhesive layer **34** has a thickness of 550 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 550 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 550 μm to 650 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 550 μm to 600 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 600 μm to 900 μm .
15 In some embodiments, the second adhesive layer **34** has a thickness of 600 μm to 850 μm . In
some embodiments, the second adhesive layer **34** has a thickness of 600 μm to 800 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 600 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 600 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 600 μm to 650 μm .

20 In some embodiments, the second adhesive layer **34** has a thickness of 650 μm to 900 μm .
In some embodiments, the second adhesive layer **34** has a thickness of 650 μm to 850 μm . In
some embodiments, the second adhesive layer **34** has a thickness of 650 μm to 800 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 650 μm to 750 μm . In some

embodiments, the second adhesive layer **34** has a thickness of 650 μm to 700 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 700 μm to 900 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 700 μm to 850 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 700 μm to 800 μm . In some
5 embodiments, the second adhesive layer **34** has a thickness of 700 μm to 750 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 750 μm to 900 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 750 μm to 850 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 750 μm to 800 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 800 μm to 900 μm . In some
10 embodiments, the second adhesive layer **34** has a thickness of 800 μm to 850 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 850 μm to 900 μm .

In some embodiments, the second adhesive layer **34** has a thickness of 1 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 50 μm . In some embodiments, the
second adhesive layer **34** has a thickness of 100 μm . In some embodiments, the second adhesive
15 layer **34** has a thickness of 1 μm . In some embodiments, the second adhesive layer **34** has a
thickness of 150 μm . In some embodiments, the second adhesive layer **34** has a thickness of 200
 μm . In some embodiments, the second adhesive layer **34** has a thickness of 250 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 300 μm . In some embodiments, the
second adhesive layer **34** has a thickness of 350 μm . In some embodiments, the second adhesive
20 layer **34** has a thickness of 400 μm . In some embodiments, the second adhesive layer **34** has a
thickness of 450 μm . In some embodiments, the second adhesive layer **34** has a thickness of 500
 μm . In some embodiments, the second adhesive layer **34** has a thickness of 550 μm . In some
embodiments, the second adhesive layer **34** has a thickness of 600 μm . In some embodiments, the

second adhesive layer **34** has a thickness of 650 μm . In some embodiments, the second adhesive layer **34** has a thickness of 700 μm . In some embodiments, the second adhesive layer **34** has a thickness of 750 μm . In some embodiments, the second adhesive layer **34** has a thickness of 800 μm . In some embodiments, the second adhesive layer **34** has a thickness of 850 μm . In some
5 embodiments, the second adhesive layer **34** has a thickness of 900 μm .

In another embodiment, the first layer **30** is attached to the second layer **32** by thermal bonding.

In some embodiments, a sealant is added to one or more edges of the roofing module **10** to prevent corrosion and delamination. In some embodiments, the sealant is a polymer sealant.

10 In some embodiments, the roofing module **10** is flexible. As used herein, the term “flexible” means capable of bending without breaking or plastic deformation, and with respect to certain embodiments of the roofing module **10**, the roofing module **10** is capable of being bent without breakage or plastic deformation of any of the layers thereof, i.e., any of the layers of the frontsheet **16**, the backsheet **28**, and the encapsulant **14**.

15 In some embodiments, a roofing system **45** includes at least one of the roofing module **10** and at least one photovoltaic module **50**. In some embodiments, the at least one of the roofing module **10** includes a plurality of roofing modules **10**. In some embodiments, the at least one photovoltaic module **50** includes a plurality of photovoltaic modules **50**. In some embodiments, the at least one photovoltaic module **50** is electrically active. In some embodiments, the system
20 includes at least one nonactive (i.e., not electrically active) roofing module **10** and at least one electrically active photovoltaic module **50**. In some embodiments, the system includes at least one nonactive roofing module **10**, at least one electrically active photovoltaic module **50**, and at least one nonactive photovoltaic module **50**. In some embodiments, the at least one roofing module **10**

and the at least one photovoltaic module **50** are installed on a roof deck **80** of a structure. In some embodiments, the appearance of the at least one roofing module **10** aesthetically matches the appearance of the at least one photovoltaic module **50**. As used herein, the term “aesthetically matches” means having a similar overall appearance, texture, gloss, and/or color, and with respect
5 to an embodiment of the roofing module **10**, the roofing module **10** includes an appearance, texture, gloss, and/or color that is similar to those of the photovoltaic module **50** when viewed from a vantage point located at a ground level of the structure. In some embodiments, the color is measured under a CIELAB color space system. In some embodiments, the gloss can be quantified in accordance with the ASTM E430 Standard Test Methods for Measurement of Gloss of High-
10 Gloss Surfaces by Abridged Goniophotometry. In some embodiments, the difference in appearance between each of the roofing module **10** and the photovoltaic module **50** are visually perceptible by and subjective to a human.

In some embodiments, the roofing module **10** includes a first thickness and the photovoltaic module **50** includes a second thickness. In some embodiments, the percentage difference between
15 the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 0.1% to 30%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 0.1% to 25%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 0.1% to 20%. In some embodiments,
20 the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 0.1% to 15%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 0.1% to 10%. In some embodiments, the percentage difference between

the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 0.1% to 5%.

In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 5% to 30%. In some
5 embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 5% to 25%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 5% to 20%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the
10 photovoltaic module **50** is 5% to 15%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 5% to 10%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 10% to 30%. In some embodiments, the percentage difference between the first thickness of the roofing module
15 **10** and the second thickness of the photovoltaic module **50** is 10% to 25%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 10% to 20%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 10% to 15%.

20 In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 15% to 30%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 15% to 25%. In some embodiments, the

percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 15% to 20%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 20% to 30%. In some embodiments, the percentage difference between
5 the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 20% to 25%. In some embodiments, the percentage difference between the first thickness of the roofing module **10** and the second thickness of the photovoltaic module **50** is 25% to 30%.

In some embodiments, the first thickness of the roofing module **10** is 5 mm to 20 mm. In some embodiments, the first thickness of the roofing module **10** is 5 mm to 15 mm. In some
10 embodiments, the first thickness of the roofing module **10** is 5 mm to 10 mm. In some embodiments, the first thickness of the roofing module **10** is 5 mm to 7 mm. In some embodiments, the first thickness of the roofing module **10** is 5 mm to 6 mm. In some embodiments, the first thickness of the roofing module **10** is 6 mm to 20 mm. In some embodiments, the first thickness of the roofing module **10** is 6 mm to 15 mm. In some embodiments, the first thickness of the
15 roofing module **10** is 6 mm to 10 mm. In some embodiments, the first thickness of the roofing module **10** is 6 mm to 7 mm.

In some embodiments, the first thickness of the roofing module **10** is 7 mm to 20 mm. In some embodiments, the first thickness of the roofing module **10** is 7 mm to 15 mm. In some
embodiments, the first thickness of the roofing module **10** is 7 mm to 10 mm. In some
20 embodiments, the first thickness of the roofing module **10** is 10 mm to 20 mm. In some embodiments, the first thickness of the roofing module **10** is 10 mm to 15 mm. In some embodiments, the first thickness of the roofing module **10** is 15 mm to 20 mm.

In some embodiments, the first thickness of the roofing module **10** is 5 mm. In some embodiments, the first thickness of the roofing module **10** is 6 mm. In some embodiments, the first thickness of the roofing module **10** is 7 mm. In some embodiments, the first thickness of the roofing module **10** is 10 mm. In some embodiments, the first thickness of the roofing module **10** is 15 mm. In some embodiments, the first thickness of the roofing module **10** is 20 mm.

In some embodiments, the second thickness of the photovoltaic module **50** is 5 mm to 20 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 5 mm to 15 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 5 mm to 10 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 5 mm to 7 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 5 mm to 6 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 6 mm to 20 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 6 mm to 15 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 6 mm to 10 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 6 mm to 7 mm.

In some embodiments, the second thickness of the photovoltaic module **50** is 7 mm to 20 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 7 mm to 15 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 7 mm to 10 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 10 mm to 20 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 10 mm to 15 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 15 mm to 20 mm.

In some embodiments, the second thickness of the photovoltaic module **50** is 5 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 6 mm. In some

embodiments, the second thickness of the photovoltaic module **50** is 7 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 10 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 15 mm. In some embodiments, the second thickness of the photovoltaic module **50** is 20 mm.

5 In some embodiments, the roofing module **10** includes a length **L1** extending from the first end **18** to the second end **20**. In some embodiments, the length **L1** is 30 inches to 80 inches. In some embodiments, the length **L1** is 30 inches to 75 inches. In some embodiments, the length **L1** is 30 inches to 70 inches. In some embodiments, the length **L1** is 30 inches to 65 inches. In some
10 embodiments, the length **L1** is 30 inches to 60 inches. In some embodiments, the length **L1** is 30 inches to 55 inches. In some embodiments, the length **L1** is 30 inches to 50 inches. In some embodiments, the length **L1** is 30 inches to 45 inches. In some embodiments, the length **L1** is 30 inches to 40 inches. In some embodiments, the length **L1** is 30 inches to 35 inches.

 In some embodiments, the length **L1** is 35 inches to 80 inches. In some embodiments, the length **L1** is 35 inches to 75 inches. In some embodiments, the length **L1** is 35 inches to 70 inches.
15 In some embodiments, the length **L1** is 35 inches to 65 inches. In some embodiments, the length **L1** is 35 inches to 60 inches. In some embodiments, the length **L1** is 35 inches to 55 inches. In some embodiments, the length **L1** is 35 inches to 50 inches. In some embodiments, the length **L1** is 35 inches to 45 inches. In some embodiments, the length **L1** is 35 inches to 40 inches. In some
20 embodiments, the length **L1** is 40 inches to 80 inches. In some embodiments, the length **L1** is 40 inches to 75 inches. In some embodiments, the length **L1** is 40 inches to 70 inches. In some embodiments, the length **L1** is 40 inches to 65 inches. In some embodiments, the length **L1** is 40 inches to 60 inches. In some embodiments, the length **L1** is 40 inches to 55 inches. In some

embodiments, the length **L1** is 40 inches to 50 inches. In some embodiments, the length **L1** is 40 inches to 45 inches.

In some embodiments, the length **L1** is 45 inches to 80 inches. In some embodiments, the length **L1** is 45 inches to 75 inches. In some embodiments, the length **L1** is 45 inches to 70 inches.

5 In some embodiments, the length **L1** is 45 inches to 65 inches. In some embodiments, the length **L1** is 45 inches to 60 inches. In some embodiments, the length **L1** is 45 inches to 55 inches. In some embodiments, the length **L1** is 45 inches to 50 inches. In some embodiments, the length **L1** is 50 inches to 80 inches. In some embodiments, the length **L1** is 50 inches to 75 inches. In some
10 embodiments, the length **L1** is 50 inches to 70 inches. In some embodiments, the length **L1** is 50 inches to 65 inches. In some embodiments, the length **L1** is 50 inches to 60 inches. In some embodiments, the length **L1** is 50 inches to 55 inches.

In some embodiments, the length **L1** is 55 inches to 80 inches. In some embodiments, the length **L1** is 55 inches to 75 inches. In some embodiments, the length **L1** is 55 inches to 70 inches. In some embodiments, the length **L1** is 55 inches to 65 inches. In some embodiments, the length
15 **L1** is 55 inches to 60 inches. In some embodiments, the length **L1** is 60 inches to 80 inches. In some embodiments, the length **L1** is 60 inches to 75 inches. In some embodiments, the length **L1** is 60 inches to 70 inches. In some embodiments, the length **L1** is 60 inches to 65 inches. In some embodiments, the length **L1** is 65 inches to 80 inches. In some embodiments, the length **L1** is 65 inches to 75 inches. In some embodiments, the length **L1** is 65 inches to 70 inches. In some
20 embodiments, the length **L1** is 70 inches to 80 inches. In some embodiments, the length **L1** is 70 inches to 75 inches. In some embodiments, the length **L1** is 75 inches to 80 inches.

In some embodiments, the length **L1** is 30 inches. In some embodiments, the length **L1** is 35 inches. In some embodiments, the length **L1** is 40 inches. In some embodiments, the length

L1 is 45 inches. In some embodiments, the length **L1** is 50 inches. In some embodiments, the length **L1** is 55 inches. In some embodiments, the length **L1** is 60 inches. In some embodiments, the length **L1** is 65 inches. In some embodiments, the length **L1** is 70 inches. In some embodiments, the length **L1** is 75 inches. In some embodiments, the length **L1** is 80 inches.

5 In some embodiments, the roofing module **10** is cuttable. In some embodiments, the roofing module **10** is cuttable to a desired size and shape. As used herein, the term “cuttable” means capable of being cut or penetrated with or as if with by an edged instrument, and with respect to certain embodiments of the roofing module **10**, the roofing module **10** is capable of being cut or penetrated by an edged instrument such as a cutting knife, scissors, razor, or other
10 suitable roofing module cutting instruments and tools. In some embodiments, the roofing module **10** is configured to be installed on the roof deck **80**. In some embodiments, the roofing module **10** is configured to be installed on non-solar roof planes of the roof deck **80**. In some embodiments, the roofing module **10** is configured to be installed either partially or fully around an array of the photovoltaic modules **50**. In some embodiments, the roofing module **10** is cuttable to a size and
15 shape for positioning around obstacles, such as vents, chimneys, antennas, and other roofing structures. In some embodiments, the roofing module **10** cuttable to a size and shape to extend to roofing eaves and ridges.

 In some embodiments, the frontsheet **16** of the roofing module **10** is textured to impart an appearance of a traditional asphalt roofing module. In some embodiments, the frontsheet **16** of
20 the roofing module **10** is textured to impart an appearance of and aesthetically match the photovoltaic modules **50**. In some embodiments, the frontsheet **16** includes an embossed surface. In some embodiments, the frontsheet **16** includes a plurality of indentations. In some

embodiments, the indentations are created by embossing a portion of the frontsheet **16**. In another embodiment, the indentations are created by embossing the polymer layer **24** of the frontsheet **16**.

In an embodiment, the frontsheet **16** includes a matte surface texture. In some embodiments, the frontsheet **16** includes a matte film. In some embodiments, the matte film
5 includes matte ETFE. In another embodiment, the matte film includes a coated film. In some embodiments, the frontsheet **16** includes a smooth surface. In some embodiments, the frontsheet **16** includes a glossy material, such as a shiny film, gloss patterned glass, or a gloss non-patterned glass. In some embodiments, the roofing module **10** having a textured frontsheet **16** is an element of the system **45** including a plurality of the roofing modules **10**, in which adjacent roofing modules
10 have textured frontsheets **16** that are patterned differently from one another, thereby imparting a random-seeming appearance to the system **45**.

In some embodiments, the first layer **14a** of the encapsulant **14** is a light scattering encapsulant layer. In some embodiments, the first layer **14a** of the encapsulant **14** has a light scattering value as measured in accordance with an ASTM E430 standard. In some embodiments,
15 the light scattering value is 0.1 HU to 12 HU. In some embodiments, the first layer **14a** of the encapsulant **14** includes a pattern. In certain embodiments, the pattern includes at least one of squares, rectangles, lozenges, diamonds, rhombuses, parallelograms, circles, hexagons, triangles, or a combination thereof. In another embodiment, a first portion of the first layer **14a** of the encapsulant **14** has a first light scattering value as measured in accordance with an ASTM E430
20 standard, and a second portion of the first layer **14a** of the encapsulant **14** has a second light scattering value as measured in accordance with the ASTM E430 standard. In some embodiments, the second light scattering value is greater than the first light scattering value. In some

embodiments, the first light scattering value is 0.1 HU to 12 HU. In some embodiments, the second light scattering value is 0.1 HU to 12 HU.

In another embodiment, the roofing module **10** includes a material similar to a standard asphalt roofing module (e.g., polymer material on asphalt). In another embodiment, the roofing module **10** includes a material similar to a non-asphalt (NAS) roofing module (e.g., polymer coated fiberglass mat). In another embodiment, the roofing module **10** includes a non-asphalt (NAS) material. In some embodiments, the NAS material includes a thermoplastic polymer. In some embodiments, the thermoplastic polymer includes at least one of a polyolefin, a vinyl polymer, and combinations thereof. In some embodiments, the polyolefin comprises one of (i) a polypropylene, (ii) a polyethylene, or (iii) a copolymer of propylene and ethylene. In some embodiments, the vinyl polymer is polyvinyl butyral (PVB). In some embodiments, the NAS material includes a filler. In some embodiments, the filler includes at least one of an organic filler, an inorganic mineral filler, or combinations thereof. In some embodiments, the filler is at least one of calcium carbonate, barium sulfate, calcium sulfate, talc, limestone, perlite, silica, fumed silica, precipitated silica, quartz, aluminum trihydrate, magnesium hydroxide, colemanite, titanium dioxide, snow white, fly ash, graphene nanoparticles, carbon black, recycled rubber tires, recycled shingles, recycled thermoplastic resins, basalt, roofing granules, clay, and combinations thereof. In other embodiments, non-limiting examples of NAS materials are disclosed in U.S. Patent Application Publication No. 2020/0224419 to Boss et al., which is incorporated by reference herein in its entirety. In another embodiment, the roofing module **10** is made from a combination of any or all of the foregoing.

In some embodiments, the roofing module **10** is adapted to be a component of a photovoltaic system that includes a fire resistance that conforms to standards under UL 790/ASTM

E 108 test standards. In some embodiments, the roofing module **10** includes a Class A rating when tested in accordance with UL 790/ASTM E 108.

In some embodiments, the roofing module **10** includes a headlap portion **36**. In some embodiments, the headlap portion **36** extends from the first end **18** to the second end **20**. In some
5 embodiments, at least a portion of a reveal portion of one of the roofing modules **10** overlays at least a portion of the headlap portion **36** of another of the roofing modules **10**. In some embodiments, at least a portion of a reveal portion of one of the photovoltaic modules **50** overlays at least a portion of the headlap portion of one of the roofing modules **10**. In some embodiments, the roofing module **10** includes at least one side lap **38**. In some embodiments, the at least one
10 side lap **38** is located at the first end **18**. In some embodiments, the at least one side lap **38** is located at the second end **20**. In some embodiments, the at least one side lap **38** includes a side lap **38** located at the first end **18** and a side lap **38** located at the second end **20**. In some embodiments, the side lap **38** of one of the roofing modules **10** overlays the side lap **38** of another of the roofing modules **10**. In some embodiments, a side lap of one of the photovoltaic modules
15 **50** overlays the side lap **38** of one of the roofing modules **10**. In some embodiments, the roofing module **10** is a watershedding layer when installed on the roof deck **80**. In some embodiments, the watershedding of the roofing module **10** is substantially similar to the watershedding of the photovoltaic module **50**.

In some embodiments, the system **45** includes at least one wireway **40** installed proximate
20 to the first end **18** of the roofing module **10**. In some embodiments, the at least one wireway **40** is installed proximate to the second end **20** of the roofing module **10**. In some embodiments, the at least one wireway **40** is installed intermediate the first end **18** of one of the roofing modules **10** and a second end **20** of another one of the roofing modules **10**. In some embodiments, the at least

one wireway **40** includes a lid. In some embodiments, the lid is removably attached to the at least one wireway **40**. In some embodiments, the at least one wireway **40** includes a plurality of the wireways **40**. In some embodiments, one of the lids of one of the plurality of wireways **40** overlaps another of the lids of another of the plurality of wireways **40**. In some embodiments, the at least
5 one wireway **40** overlays a corresponding one of the side laps **38**. In some embodiments, the at least one wireway **40** includes a height of 1 mm to 20 mm. In some embodiments, the at least one wireway **40** includes a single wireway installed proximate to the first end of each of the roofing modules **10**. In some embodiments, the at least one wireway **40** does not include any electrical components or electrical wires or cables therein.

10 In some embodiments, a method includes the steps of:

- obtaining a plurality of the roofing modules **10**
- obtaining a plurality of the photovoltaic modules **50**
- installing the plurality of photovoltaic modules **50** on the roof deck **80**;
- cutting at least one of the plurality of roofing modules **10** to a size and shape; and
15 • installing the plurality of roofing modules **10** on the roof deck **80** proximate to the

plurality of photovoltaic modules **50**, the at least one cell **12** of each of the plurality of roofing modules **10** is electrically inactive, and the at least one solar cell of at least one of the plurality of photovoltaic modules **50** is electrically active.

In some embodiments, the plurality of roofing modules **10** and the plurality of photovoltaic
20 modules **50** are installed on the roof deck **80** a single roof face. In another embodiment, the plurality of roofing modules **10** and the plurality of photovoltaic modules **50** are installed on the roof deck **80** in multiple roof faces. In another embodiment, the plurality of roofing modules **10** and the plurality of photovoltaic modules **50** are installed on all faces of the roof deck **80**. In some

embodiments, the system includes a plurality of roofing shingles. In some embodiments, the plurality of roofing shingles includes asphalt shingles.

FIGS. 3 shows an embodiment of a roofing module **110**. The roofing module **110** includes a structure and function similar to the roofing module **10**, except for certain differences described hereinafter. In some embodiments, the roofing module **110** includes a first layer **112**, an encapsulant **114** encapsulating the first layer **112**, a frontsheet **116** juxtaposed with a first layer **114a** of the encapsulant **114**, and a backsheet **128** juxtaposed with a second layer **114b** of the encapsulant **114**. In some embodiments, the first layer **114a** of the encapsulant **114** is a UV blocking encapsulant layer. In some embodiments, the first layer **114a** of the encapsulant **114** is a non-UV blocking encapsulant layer.

In some embodiments, the frontsheet **116** includes a fluoropolymer. In certain embodiments, the fluoropolymer may be ethylene tetrafluoroethylene (ETFE), fluoropolymer is polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), and tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), polyvinyl fluoride (PVF), or blends thereof. In some embodiments, the frontsheet includes fluoropolymers, acrylics, polyesters, silicones, polycarbonates, or combinations thereof. In other embodiments, the frontsheet **116** includes polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyaryletherketone (PAEK), polyarylate (PAR), polyetherimide (PEI), polyarylsulfone (PAS), polyethersulfone (PES), polyamideimide (PAI), polyphenylsulfone (PPSU), polyolefin, cyclic olefin copolymers (CPCs), or polyimide. In some embodiments, the frontsheet **116** includes an ultraviolet (UV) light blocking film. In some embodiments, the frontsheet **116** includes a crosslinked polymeric material. In some embodiments, 50% to 99% of

the polymer chains of the polymeric material are crosslinked. In some embodiments, the frontsheet **116** includes a single layer.

In some embodiments, the first layer **112** includes polyethylene terephthalate (PET). In another embodiment, the first layer **112** includes thermoplastic polyolefin (TPO). In some
5 embodiments, the first layer **112** includes a single ply TPO roofing membrane. In some
embodiments, the first layer **112** is plasma-treated. In some embodiments, the plasma-treated first
layer **112** includes thermoplastic polyolefins (TPO), polyvinyl chlorides (PVC), cyclopiazonic
acid (CPA), chlorinated polyethylene resins (CPE), ethylene interpolymers (EIP), nitrile butadiene
polymers (NBP), polyisobutylenes (PIB), atactic-polypropylene (APP), APP-modified bitumen,
10 poly(styrene-butadiene-styrene) (SBS), styrene ethylene butylene styrene (SEBS), ethylene
propylene diene monomers (EDPM), chlorosulfonated polyethylene rubbers (CSPE),
polychloroprene (CR), extracellular region membranes (ECR), polycarbonate, nylon, polyvinyl
acetate, polystyrene, polytetrafluoroethylene, polyvinylidene fluoride (PVDF), polyurethane,
epoxy and the like. In some embodiments, the first layer **112** includes a non-asphalt (NAS) roofing
15 material. In some embodiments, the NAS material includes a thermoplastic polymer. In some
embodiments, the thermoplastic polymer includes at least one of a polyolefin, a vinyl polymer,
and combinations thereof. In some embodiments, the polyolefin comprises one of (i) a
polypropylene, (ii) a polyethylene, or (iii) a copolymer of propylene and ethylene. In some
embodiments, the vinyl polymer is polyvinyl butyral (PVB). In some embodiments, the NAS
20 material includes a filler. In some embodiments, the filler includes at least one of an organic filler,
an inorganic mineral filler, or combinations thereof. In some embodiments, the filler is at least
one of calcium carbonate, barium sulfate, calcium sulfate, talc, limestone, perlite, silica, fumed
silica, precipitated silica, quartz, aluminum trihydrate, magnesium hydroxide, colemanite, titanium

dioxide, snow white, fly ash, graphene nanoparticles, carbon black, recycled rubber tires, recycled shingles, recycled thermoplastic resins, basalt, roofing granules, clay, and combinations thereof. In other embodiments, non-limiting examples of NAS materials are disclosed in U.S. Patent Application Publication No. 2020/0224419 to Boss et al., which is incorporated by reference
5 herein in its entirety.

In some embodiments, the first layer **112** includes polyvinyl chloride (PVC). In some embodiments, the first layer **112** includes ethylene propylene diene monomer (EPDM) rubber. In some embodiments, a pattern is printed on a first surface **113** of the first layer **112**. In some
10 embodiments, a pattern or depiction of solar cells is printed on the first surface **113** of the first layer **112**. In some embodiments, the pattern or depiction of solar cells includes a depiction of a plurality of cell fingers. In some embodiments, the depiction of the plurality of cell fingers is similar in size, shape and grain pattern of cell fingers **1340** described below. In some
15 embodiments, the pattern is printed on the first surface **113** of the first layer **112** by ink jet printing. In some embodiments, the pattern is printed on the first surface **113** of the first layer **112** by laser
printing. In some embodiments, the pattern is printed on the first surface **113** of the first layer **112**
by lithography. In some embodiments, the pattern is printed on the first surface **113** of the first
layer **112** by flexography. In another embodiment, the first layer **112** is painted. In another
embodiment, the first layer **112** is a colored layer. In another embodiment, the first layer **112**
includes a black color. In some embodiments, the color of the first layer **112** includes a mixture
20 of colors. In some embodiments, the first layer **112** includes an infrared reflective pigment. In
some embodiments, the infrared reflective pigment includes graphene. In some embodiments, the
roofing module **110** meets standards of California Building Energy Efficiency Standards of
Residential and Nonresidential Buildings, Title 24, Part 6.

In some embodiments, the first layer **112** includes magnesium oxide (MgO). In some embodiments, the first layer **112** includes 35% to 50% by weight of MgO. In some embodiments, the first layer **112** includes 35% to 45% by weight of MgO. In some embodiments, the first layer **112** includes 35% to 40% by weight of MgO. In some embodiments, the first layer **112** includes 40% to 50% by weight of MgO. In some embodiments, the first layer **112** includes 40% to 45% by weight of MgO. In some embodiments, the first layer **112** includes 45% to 50% by weight of MgO. In some embodiments, the first layer **112** includes 35% by weight of MgO. In some embodiments, the first layer **112** includes 40% by weight of MgO. In some embodiments, the first layer **112** includes 45% by weight of MgO. In some embodiments, the first layer **112** includes 50% by weight of MgO.

In some embodiments, the first layer **112** includes magnesium hydroxide (Mg(OH)₂). In some embodiments, the first layer **112** includes 35% to 50% by weight of Mg(OH)₂. In some embodiments, the first layer **112** includes 35% to 45% by weight of Mg(OH)₂. In some embodiments, the first layer **112** includes 35% to 40% by weight of Mg(OH)₂. In some embodiments, the first layer **112** includes 40% to 50% by weight of Mg(OH)₂. In some embodiments, the first layer **112** includes 40% to 45% by weight of Mg(OH)₂. In some embodiments, the first layer **112** includes 45% to 50% by weight of Mg(OH)₂. In some embodiments, the first layer **112** includes 35% by weight of Mg(OH)₂. In some embodiments, the first layer **112** includes 40% by weight of Mg(OH)₂. In some embodiments, the first layer **112** includes 45% by weight of Mg(OH)₂. In some embodiments, the first layer **112** includes 50% by weight of Mg(OH)₂.

In some embodiments, the first layer **112** includes ketone ethylene ester (KEE). In some embodiments, the first layer **112** includes a PVC-KEE hybrid membrane. In some embodiments,

the roofing module **110** is adapted to be a component of a photovoltaic system that includes a fire resistance that conforms to standards under UL 790/ASTM E 108 test standards. In some embodiments, the roofing module **110** includes a Class A rating when tested in accordance with UL 790/ASTM E 108.

5 In some embodiments, the first layer **112** has a thickness of 0.1 mm to 1 mm. In some embodiments, the first layer **112** has a thickness of 0.1 mm to 0.9 mm. In some embodiments, the first layer **112** has a thickness of 0.1 mm to 0.8 mm. In some embodiments, the first layer **112** has a thickness of 0.1 mm to 0.7 mm. In some embodiments, the first layer **112** has a thickness of 0.1 mm to 0.6 mm. In some embodiments, the first layer **112** has a thickness of 0.1 mm to 0.5 mm.

10 In some embodiments, the first layer **112** has a thickness of 0.1 mm to 0.4 mm. In some embodiments, the first layer **112** has a thickness of 0.1 mm to 0.3 mm. In some embodiments, the first layer **112** has a thickness of 0.1 mm to 0.2 mm.

 In some embodiments, the first layer **112** has a thickness of 0.2 mm to 1 mm. In some embodiments, the first layer **112** has a thickness of 0.2 mm to 0.9 mm. In some embodiments, the first layer **112** has a thickness of 0.2 mm to 0.8 mm. In some embodiments, the first layer **112** has a thickness of 0.2 mm to 0.7 mm. In some embodiments, the first layer **112** has a thickness of 0.2 mm to 0.6 mm. In some embodiments, the first layer **112** has a thickness of 0.2 mm to 0.5 mm. In some embodiments, the first layer **112** has a thickness of 0.2 mm to 0.4 mm. In some embodiments, the first layer **112** has a thickness of 0.2 mm to 0.3 mm.

20 In some embodiments, the first layer **112** has a thickness of 0.3 mm to 1 mm. In some embodiments, the first layer **112** has a thickness of 0.3 mm to 0.9 mm. In some embodiments, the first layer **112** has a thickness of 0.3 mm to 0.8 mm. In some embodiments, the first layer **112** has a thickness of 0.3 mm to 0.7 mm. In some embodiments, the first layer **112** has a thickness of 0.3

mm to 0.6 mm. In some embodiments, the first layer **112** has a thickness of 0.3 mm to 0.5 mm. In some embodiments, the first layer **112** has a thickness of 0.3 mm to 0.4 mm. In some embodiments, the first layer **112** has a thickness of 0.4 mm to 1 mm. In some embodiments, the first layer **112** has a thickness of 0.4 mm to 0.9 mm. In some embodiments, the first layer **112** has a thickness of 0.4 mm to 0.8 mm. In some embodiments, the first layer **112** has a thickness of 0.4 mm to 0.7 mm. In some embodiments, the first layer **112** has a thickness of 0.4 mm to 0.6 mm. In some embodiments, the first layer **112** has a thickness of 0.4 mm to 0.5 mm.

In some embodiments, the first layer **112** has a thickness of 0.5 mm to 1 mm. In some embodiments, the first layer **112** has a thickness of 0.5 mm to 0.9 mm. In some embodiments, the first layer **112** has a thickness of 0.5 mm to 0.8 mm. In some embodiments, the first layer **112** has a thickness of 0.5 mm to 0.7 mm. In some embodiments, the first layer **112** has a thickness of 0.5 mm to 0.6 mm. In some embodiments, the first layer **112** has a thickness of 0.6 mm to 1 mm. In some embodiments, the first layer **112** has a thickness of 0.6 mm to 0.9 mm. In some embodiments, the first layer **112** has a thickness of 0.6 mm to 0.8 mm. In some embodiments, the first layer **112** has a thickness of 0.6 mm to 0.7 mm. In some embodiments, the first layer **112** has a thickness of 0.7 mm to 1 mm. In some embodiments, the first layer **112** has a thickness of 0.7 mm to 0.9 mm. In some embodiments, the first layer **112** has a thickness of 0.7 mm to 0.8 mm. In some embodiments, the first layer **112** has a thickness of 0.8 mm to 1 mm. In some embodiments, the first layer **112** has a thickness of 0.8 mm to 0.9 mm. In some embodiments, the first layer **112** has a thickness of 0.9 mm to 1 mm.

In some embodiments, the backsheet **128** includes a polymeric material. In some embodiments, the backsheet **128** includes thermoplastic polyolefin (TPO). In some embodiments, the backsheet **128** includes a single ply TPO roofing membrane. In other embodiments, non-

limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is incorporated by reference herein in its entirety. In another embodiment, the backsheet includes polyethylene terephthalate (“PET”). In another embodiment, the backsheet **128** includes ethylene tetrafluoroethylene (“ETFE”). In some embodiments, the backsheet **128** includes an acrylic such as polymethyl methacrylate (“PMMA”). In another embodiment, the backsheet **128** includes polyvinyl chloride. In some embodiments, the backsheet **128** includes ethylene propylene diene monomer (EPDM) rubber. In some embodiments, the backsheet **128** includes a flame retardant additive. In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof. In some embodiments, the backsheet **128** is a single layer. **FIG. 5** shows a prototype of an embodiment of the roofing module **110** pre-lamination and post-lamination thereof.

In some embodiments, the roofing module **110** is cuttable. In some embodiments, the roofing module **110** is cuttable to a desired size and shape.

In some embodiments, a method includes the steps of:

- obtaining a plurality of the roofing modules **110**;
- obtaining a plurality of the photovoltaic modules **50**;
- installing the plurality of the photovoltaic modules **50** on the roof deck **80**;
- cutting at least one of the plurality of roofing modules **110** to a size and shape; and
- installing the plurality of roofing modules **110** on the roof deck **80** proximate to the plurality of photovoltaic modules **50**, wherein the at least one solar cell of at least one of the plurality of the photovoltaic modules **50** is electrically active.

FIG. 4 shows an embodiment of a roofing module **210**. The roofing module **210** includes a structure and function similar to the roofing module **110**, except for certain differences described hereinafter. In some embodiments, the roofing module **210** includes an encapsulant **214**, a frontsheet **216** juxtaposed with a first surface of the encapsulant **214**, and a backsheet **228** juxtaposed with a second surface of the encapsulant **214**. In some embodiments, the encapsulant **214** is a UV blocking encapsulant. In some embodiments, the encapsulant **214** is a non-UV blocking encapsulant.

In some embodiments, the frontsheet **216** includes a fluoropolymer. In certain embodiments, the fluoropolymer may be ethylene tetrafluoroethylene (ETFE), fluoropolymer is polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), and tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), polyvinyl fluoride (PVF), or blends thereof. In some embodiments, the frontsheet includes fluoropolymers, acrylics, polyesters, silicones, polycarbonates, or combinations thereof. In other embodiments, the frontsheet **216** includes polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyaryletherketone (PAEK), polyarylate (PAR), polyetherimide (PEI), polyarylsulfone (PAS), polyethersulfone (PES), polyamideimide (PAI), polyphenylsulfone (PPSU), polyolefin, cyclic olefin copolymers (CPCs), or polyimide. In some embodiments, the frontsheet **216** includes an ultraviolet (UV) light blocking film. In some embodiments, the frontsheet **216** includes a crosslinked polymeric material. In some embodiments, 50% to 99% of the polymer chains of the polymeric material are crosslinked. In some embodiments, the frontsheet **216** includes a single layer.

In some embodiments, the backsheet **228** includes a polymeric material. In some embodiments, the backsheet **228** includes thermoplastic polyolefin (TPO). In some embodiments,

the backsheet **228** is plasma-treated. In some embodiments, the plasma-treated backsheet **228** includes thermoplastic polyolefins (TPO), polyvinyl chlorides (PVC), cyclopiazonic acid (CPA), chlorinated polyethylene resins (CPE), ethylene interpolymers (EIP), nitrile butadiene polymers (NBP), polyisobutylenes (PIB), atactic-polypropylene (APP), APP-modified bitumen, 5 poly(styrene-butadiene-styrene) (SBS), styrene ethylene butylene styrene (SEBS), ethylene propylene diene monomers (EDPM), chlorosulfonated polyethylene rubbers (CSPE), polychloroprene (CR), extracellular region membranes (ECR), polycarbonate, nylon, polyvinyl acetate, polystyrene, polytetrafluoroethylene, polyvinylidene fluoride (PVDF), polyurethane, epoxy and the like. In some embodiments, the backsheet **228** includes a non-asphalt (NAS) roofing 10 material.

In some embodiments, the NAS material includes a thermoplastic polymer. In some embodiments, the thermoplastic polymer includes at least one of a polyolefin, a vinyl polymer, and combinations thereof. In some embodiments, the polyolefin comprises one of (i) a polypropylene, (ii) a polyethylene, or (iii) a copolymer of propylene and ethylene. In some 15 embodiments, the vinyl polymer is polyvinyl butyral (PVB). In some embodiments, the NAS material includes a filler. In some embodiments, the filler includes at least one of an organic filler, an inorganic mineral filler, or combinations thereof. In some embodiments, the filler is at least one of calcium carbonate, barium sulfate, calcium sulfate, talc, limestone, perlite, silica, fumed silica, precipitated silica, quartz, aluminum trihydrate, magnesium hydroxide, colemanite, titanium 20 dioxide, snow white, fly ash, graphene nanoparticles, carbon black, recycled rubber tires, recycled shingles, recycled thermoplastic resins, basalt, roofing granules, clay, and combinations thereof. In other embodiments, non-limiting examples of NAS materials are disclosed in U.S. Patent

Application Publication No. 2020/0224419 to Boss et al., which is incorporated by reference herein in its entirety.

In some embodiments, the backsheet **228** includes polyvinyl chloride (PVC). In some embodiments, the backsheet **228** includes a single ply TPO roofing membrane. In other
5 embodiments, non-limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is incorporated by reference herein in its entirety. In another embodiment, the backsheet includes polyethylene terephthalate ("PET"). In another embodiment, the backsheet **228** includes ethylene tetrafluoroethylene ("ETFE"). In some embodiments, the backsheet **228** includes an acrylic such as polymethyl methacrylate ("PMMA"). In another
10 embodiment, the backsheet **228** includes polyvinyl chloride. In some embodiments, the backsheet **228** includes ethylene propylene diene monomer (EPDM) rubber. In some embodiments, the backsheet **228** includes a flame retardant additive. In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof. In some embodiments, the backsheet
15 **228** is a single layer. In some embodiments, a pattern or depiction of solar cells is printed on a first surface of the backsheet **228**. In some embodiments, the pattern or depiction of solar cells includes a depiction of a plurality of cell fingers. In some embodiments, the depiction of the plurality of cell fingers is similar in size, shape and grain pattern of the cell fingers **1340** described below. In another embodiment, the backsheet **228** is painted. In another embodiment, the
20 backsheet **228** includes a black color. In some embodiments, the backsheet **228** includes an infrared reflective pigment. In some embodiments, the infrared reflective pigment includes graphene. In some embodiments, the roofing module **210** meets standards of California Building Energy Efficiency Standards of Residential and Nonresidential Buildings, Title 24, Part 6.

In some embodiments, the backsheet **228** includes magnesium oxide (MgO). In some embodiments, the backsheet **228** includes 35% to 50% by weight of MgO. In some embodiments, the backsheet **228** includes 35% to 45% by weight of MgO. In some embodiments, the backsheet **228** includes 35% to 40% by weight of MgO. In some embodiments, the backsheet **228** includes 40% to 50% by weight of MgO. In some embodiments, the backsheet **228** includes 40% to 45% by weight of MgO. In some embodiments, the backsheet **228** includes 45% to 50% by weight of MgO. In some embodiments, the backsheet **228** includes 35% by weight of MgO. In some embodiments, the backsheet **228** includes 40% by weight of MgO. In some embodiments, the backsheet **228** includes 45% by weight of MgO. In some embodiments, the backsheet **228** includes 50% by weight of MgO.

In some embodiments, the backsheet **228** includes ketone ethylene ester (KEE). In some embodiments, the backsheet **228** includes a PVC-KEE hybrid membrane. In some embodiments, the roofing module **210** is adapted to be a component of a photovoltaic system that includes a fire resistance that conforms to standards under UL 790/ASTM E 108 test standards. In some embodiments, the roofing module **210** includes a Class A rating when tested in accordance with UL 790/ASTM E 108.

In some embodiments, a method includes the steps of:

- obtaining a plurality of the roofing modules **210**;
- obtaining a plurality of the photovoltaic modules **50**;
- installing the plurality of the photovoltaic modules **50** on the roof deck **80**;
- cutting at least one of the plurality of roofing modules **210** to a size and shape; and

- installing the plurality of roofing modules **210** on the roof deck **80** proximate to the plurality of photovoltaic modules **50**, wherein the at least one solar cell of at least one of the plurality of the photovoltaic modules **50** is electrically active.

In some embodiments, the roofing module **210** is cuttable. In some embodiments, the roofing module **210** is cuttable to a desired size and shape.

FIG. 6 shows an embodiments of the roofing modules **10**, **110**, **210** on a roof deck. Option 1 shows the non-active roofing modules **110** and the active photovoltaic modules **50** on the roof deck **80**. Option 2 shows the nonactive roofing modules **10** and the active photovoltaic modules **50** on the roof deck **80**. Option 3 shows the nonactive roofing modules **210** and the active photovoltaic modules **50** on the roof deck **80**.

FIG. 7 shows another embodiment of a roofing module **310**. The roofing module **310** includes a structure and function similar to the roofing module **210**, except for certain differences described hereinafter. In some embodiments, the roofing module **310** includes a layer **312** having a first surface and a second surface opposite the first surface, a frontsheet **316** juxtaposed with a first surface of the layer **312**, and an encapsulant **314** having a first surface and a second surface opposite the first surface, and juxtaposed with a second surface of the layer **312**. In some embodiments, a pattern is printed on a first surface of the layer **312**. In some embodiments, a pattern or depiction of solar cells is printed on the first surface of the layer **312**. In some embodiments, the pattern or depiction of solar cells includes a depiction of a plurality of cell fingers. In some embodiments, the depiction of the plurality of cell fingers is similar in size, shape and grain pattern of the cell fingers **1340** described below. In some embodiments, the layer **312** is rigid. As used herein, the term “rigid” means substantially stiff. In some embodiments, the layer **312** is made from metal. In some embodiments, the layer **312** is made from aluminum. In some

embodiments, the layer **312** is made from galvanized aluminum. In another embodiment, the layer **312** is made from an FR-4 glass-reinforced epoxy laminate material.

In some embodiments, the layer **312** includes a thickness of 0.01 inch to 0.1 inch. In another embodiment, the layer **312** includes a thickness of 0.01 inch to 0.09 inch. In another
5 embodiment, the layer **312** includes a thickness of 0.01 inch to 0.08 inch. In another embodiment, the layer **312** includes a thickness of 0.01 inch to 0.07 inch. In another embodiment, the layer **312** includes a thickness of 0.01 inch to 0.06 inch. In another embodiment, the layer **312** includes a thickness of 0.01 inch to 0.05 inch. In another embodiment, the layer **312** includes a thickness of 0.01 inch to 0.04 inch. In another embodiment, the layer **312** includes a thickness of 0.01 inch to
10 0.03 inch. In another embodiment, the layer **312** includes a thickness of 0.01 inch to 0.02 inch.

In some embodiments, the layer **312** includes a thickness of 0.02 inch to 0.1 inch. In another embodiment, the layer **312** includes a thickness of 0.02 inch to 0.09 inch. In another embodiment, the layer **312** includes a thickness of 0.02 inch to 0.08 inch. In another embodiment, the layer **312** includes a thickness of 0.02 inch to 0.07 inch. In another embodiment, the layer **312**
15 includes a thickness of 0.02 inch to 0.06 inch. In another embodiment, the layer **312** includes a thickness of 0.02 inch to 0.05 inch. In another embodiment, the layer **312** includes a thickness of 0.02 inch to 0.04 inch. In another embodiment, the layer **312** includes a thickness of 0.02 inch to 0.03 inch.

In some embodiments, the layer **312** includes a thickness of 0.03 inch to 0.1 inch. In
20 another embodiment, the layer **312** includes a thickness of 0.03 inch to 0.09 inch. In another embodiment, the layer **312** includes a thickness of 0.03 inch to 0.08 inch. In another embodiment, the layer **312** includes a thickness of 0.03 inch to 0.07 inch. In another embodiment, the layer **312** includes a thickness of 0.03 inch to 0.06 inch. In another embodiment, the layer **312** includes a

thickness of 0.03 inch to 0.05 inch. In another embodiment, the layer **312** includes a thickness of 0.03 inch to 0.04 inch.

In some embodiments, the layer **312** includes a thickness of 0.04 inch to 0.1 inch. In another embodiment, the layer **312** includes a thickness of 0.04 inch to 0.09 inch. In another
5 embodiment, the layer **312** includes a thickness of 0.04 inch to 0.08 inch. In another embodiment, the layer **312** includes a thickness of 0.04 inch to 0.07 inch. In another embodiment, the layer **312** includes a thickness of 0.04 inch to 0.06 inch. In another embodiment, the layer **312** includes a thickness of 0.04 inch to 0.05 inch. In some embodiments, the layer **312** includes a thickness of
10 0.05 inch to 0.1 inch. In another embodiment, the layer **312** includes a thickness of 0.05 inch to 0.09 inch. In another embodiment, the layer **312** includes a thickness of 0.05 inch to 0.08 inch. In another embodiment, the layer **312** includes a thickness of 0.05 inch to 0.07 inch. In another embodiment, the layer **312** includes a thickness of 0.05 inch to 0.06 inch.

In some embodiments, the layer **312** includes a thickness of 0.06 inch to 0.1 inch. In another embodiment, the layer **312** includes a thickness of 0.06 inch to 0.09 inch. In another
15 embodiment, the layer **312** includes a thickness of 0.06 inch to 0.08 inch. In another embodiment, the layer **312** includes a thickness of 0.06 inch to 0.07 inch. In some embodiments, the layer **312** includes a thickness of 0.07 inch to 0.1 inch. In another embodiment, the layer **312** includes a thickness of 0.07 inch to 0.09 inch. In another embodiment, the layer **312** includes a thickness of
20 0.07 inch to 0.08 inch. In some embodiments, the layer **312** includes a thickness of 0.08 inch to 0.1 inch. In another embodiment, the layer **312** includes a thickness of 0.08 inch to 0.09 inch. In some embodiments, the layer **312** includes a thickness of 0.09 inch to 0.1 inch.

In some embodiments, the layer **312** includes a thickness of 0.01 inch. In some embodiments, the layer **312** includes a thickness of 0.02 inch. In some embodiments, the layer

312 includes a thickness of 0.03 inch. In some embodiments, the layer **312** includes a thickness of 0.04 inch. In some embodiments, the layer **312** includes a thickness of 0.05 inch. In some embodiments, the layer **312** includes a thickness of 0.06 inch. In some embodiments, the layer **312** includes a thickness of 1/16 inch. In some embodiments, the layer **312** includes a thickness of 0.07 inch. In some embodiments, the layer **312** includes a thickness of 0.08 inch. In some embodiments, the layer **312** includes a thickness of 0.09 inch. In some embodiments, the layer **312** includes a thickness of 0.1 inch.

In some embodiments, the frontsheet **316** is a UV blocking frontsheet. In some embodiments, the frontsheet **316** is a non-UV blocking frontsheet. In some embodiments, the frontsheet **316** is a UV blocking coating. In some embodiments, a backsheet **328** is juxtaposed with the second surface of the encapsulant **314**. In other embodiments, the backsheet **328** includes a structure and materials similar to the backsheet **228**. In some embodiments, the backsheet **328** includes thermoplastic polyolefin (TPO).

In some embodiments, the roofing module **310** is cuttable. In some embodiments, the roofing module **310** is cuttable to a desired size and shape.

FIG. 8 shows another embodiment of a roofing module **410**. The roofing module **410** includes a structure and function similar to the roofing module **310**, except for certain differences described hereinafter. In some embodiments, the roofing module **410** includes a layer **412** having a first surface and a second surface opposite the first surface, an encapsulant **414** having a first surface and a second surface opposite the first surface and juxtaposed with a first surface of the layer **412**, a layer **428** having a first surface and a second surface opposite the first surface and juxtaposed with the first surface of the encapsulant **414**, and a frontsheet **416** juxtaposed with the first surface of the layer **428**. In some embodiments, a pattern is printed on a first surface of the

layer **428**. In some embodiments, a pattern or depiction of solar cells is printed on the first surface of the layer **428**. In some embodiments, the pattern or depiction of solar cells includes a depiction of a plurality of cell fingers. In some embodiments, the depiction of the plurality of cell fingers is similar in size, shape and grain pattern of the cell fingers **1340** described below. In some
5 embodiments, the layer **428** includes a structure and materials similar to the backsheet **228**. In some embodiments, the layer **428** includes thermoplastic polyolefin (TPO).

In some embodiments, the layer **412** is rigid. In some embodiments, the layer **412** is made from metal. In some embodiments, the layer **412** is made from aluminum. In some embodiments, the layer **412** is made from galvanized aluminum. In another embodiment, the layer **412** is made
10 from an FR-4 glass-reinforced epoxy laminate material. In some embodiments, the frontsheet **416** is a UV blocking frontsheet. In some embodiments, the frontsheet **416** is a non-UV blocking frontsheet. In some embodiments, the frontsheet **416** is a UV blocking coating.

In some embodiments, the roofing module **410** is cuttable. In some embodiments, the roofing module **410** is cuttable to a desired size and shape.

FIG. 9 shows another embodiment of a roofing module **510**. In some embodiments, the roofing module **510** includes a first layer **528** having a first surface, a second layer **529** having a second surface, and a third layer **512** intermediate the first layer **528** and the second layer **529**. In some embodiments, the first layer **528** includes a first end **511** and the second layer **529** includes a first end **513**. In some embodiments, each of the first layer **528** and the second layer **529** is made
15 from materials similar to those of the backsheet **228**. In some embodiments, each of the first layer **528** and the second layer **529** is made from thermoplastic polyolefin (TPO). In some embodiments, the first end **511** of the first layer **528** and the first end **513** of the second layer **529** are unitary. In some
20 embodiments, a pattern is printed on a first surface of the first layer **528**. In some

embodiments, a pattern or depiction of solar cells is printed on the first surface of the first layer **528**. In some embodiments, the pattern or depiction of solar cells includes a depiction of a plurality of cell fingers. In some embodiments, the depiction of the plurality of cell fingers is similar in size, shape and grain pattern of the cell fingers **1340** described below.

5 In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 1 mm to 10 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 1 mm to 9 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 1 mm to 8 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 1 mm to 7 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 1 mm to 6 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 1 mm to 5 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 1 mm to 4 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 1 mm to 3 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 1 mm to 2 mm.

 In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 2 mm to 10 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 2 mm to 9 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 2 mm to 8 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 2 mm to 7 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 2 mm to 6 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 2 mm to 5 mm. In another embodiment, the first layer **528** and the second layer **529** include a total

thickness **T** of 2 mm to 4 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 2 mm to 3 mm.

In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 3 mm to 10 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 3 mm to 9 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 3 mm to 8 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 3 mm to 7 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 3 mm to 6 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 3 mm to 5 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 3 mm to 4 mm.

In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 4 mm to 10 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 4 mm to 9 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 4 mm to 8 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 4 mm to 7 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 4 mm to 6 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 4 mm to 5 mm.

In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 5 mm to 10 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 5 mm to 9 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 5 mm to 8 mm. In another embodiment, the first layer **528**

and the second layer **529** include a total thickness **T** of 5 mm to 7 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 5 mm to 6 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 6 mm to 10 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 6 mm to 9 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 6 mm to 8 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 6 mm to 7 mm.

In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 7 mm to 10 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 7 mm to 9 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 7 mm to 8 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 8 mm to 10 mm. In another embodiment, the first layer **528** and the second layer **529** include a total thickness **T** of 8 mm to 9 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 9 mm to 10 mm.

In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 1 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 2 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 3 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 4 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 5 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 6 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 7 mm. In some embodiments, the first

layer **528** and the second layer **529** include a total thickness **T** of 8 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 9 mm. In some embodiments, the first layer **528** and the second layer **529** include a total thickness **T** of 10 mm.

In some embodiments, the third layer **512** is rigid. In some embodiments, the third layer **512** is made of metal. In some embodiments, the third layer **512** is made of aluminum. In some embodiments, the third layer **512** includes galvanized aluminum. In another embodiment, the third layer **512** is made from an FR-4 glass-reinforced epoxy laminate material. In some embodiments, the third layer **512** includes a scrim. In some embodiments, the scrim may be made from polyesters, polyethylene, carbon fiber, fiberglass, aramids, and combinations thereof. In some embodiments, the third layer **512** is a flame retardant layer. In some embodiments, the third layer **512** includes a flame retardant additive. In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof.

In some embodiments, the roofing module **510** includes a frontsheet **516** juxtaposed with the first surface of the first layer **528**. In some embodiments, the frontsheet **516** is a UV blocking frontsheet. In some embodiments, the frontsheet **516** is a non-UV blocking frontsheet. In some embodiments, the frontsheet **516** is a UV blocking coating. In some embodiments, the frontsheet **516** is a UV blocking film.

In some embodiments, the roofing module **510** is cuttable. In some embodiments, the roofing module **510** is cuttable to a desired size and shape.

FIG. 10 shows another embodiment of a roofing module **610**. In some embodiments, the roofing module **610** includes a layer **612** and an encapsulant **614** encapsulating the layer **612**. In some embodiments, the encapsulant **614** includes a first layer **614a** and a second layer **614b**, In

some embodiments, the first layer **614a** is a UV blocking encapsulant layer. In some embodiments, the first layer **614a** of the encapsulant **614** is a non-UV blocking encapsulant layer.

In some embodiments, the layer **612** includes a structure and/or is made from materials similar to those of the first layer **112**. In some embodiments, the layer **612** includes polyethylene terephthalate (PET). In another embodiment, the layer **612** includes thermoplastic polyolefin (TPO). In some embodiments, a pattern is printed on a first surface of the layer **612**. In some embodiments, a pattern or depiction of solar cells is printed on the first surface of the layer **612**. In some embodiments, the pattern or depiction of solar cells includes a depiction of a plurality of cell fingers. In some embodiments, the depiction of the plurality of cell fingers is similar in size, shape and grain pattern of the cell fingers **1340** described below. In some embodiments, the layer **612** does not include any printing. In some embodiments, the roofing module **610** includes a frontsheet **616**. In some embodiments, the frontsheet **616** is a non-UV blocking frontsheet. In some embodiments, the frontsheet **616** is a UV blocking coating. In some embodiments, the frontsheet **616** is a UV blocking film.

In some embodiments, the roofing module **610** includes a backsheet **628**. In some embodiments, the backsheet **628** is made from materials similar to those of the backsheet **28**. In some embodiments, the backsheet **628** is made from thermoplastic polyolefin (TPO). In some embodiments, the backsheet **628** includes a thickness **T** of 1 mm to 10 mm.

In some embodiments, the roofing module **610** is cuttable. In some embodiments, the roofing module **610** is cuttable to a desired size and shape.

FIG. 11 shows another embodiment of a roofing module **710**. In some embodiments, the roofing module **710** includes a layer **712** and an encapsulant **714** encapsulating the layer **712**. In some embodiments, the encapsulant **714** includes a first layer **714a** and a second layer **714b**, In

some embodiments, the first layer **714a** is a UV blocking encapsulant layer. In some embodiments, the first layer **714a** of the encapsulant **714** is a non-UV blocking encapsulant layer.

In some embodiments, the layer **712** is rigid. In some embodiments, the layer **712** is made of metal. In some embodiments, the layer **712** is made of aluminum. In some embodiments, the layer **712** includes galvanized aluminum. In another embodiment, the layer **712** is made from an FR-4 glass-reinforced epoxy laminate material. In some embodiments, the roofing module **710** includes a frontsheet **716**. In some embodiments, the frontsheet **716** is a non-UV blocking frontsheet. In some embodiments, the frontsheet **716** is a UV blocking coating. In some embodiments, the frontsheet **716** is a UV blocking film. In some embodiments, the roofing module **710** includes a backsheet **728**. In some embodiments, the backsheet **728** is made from materials similar to those of the backsheet **28**. In some embodiments, the backsheet **728** is made from thermoplastic polyolefin (TPO).

In some embodiments, the roofing module **710** is cuttable. In some embodiments, the roofing module **710** is cuttable to a desired size and shape.

FIG. 12A shows an embodiment of a plurality of roofing modules **810**. In some embodiments, each of the roofing modules **810** is textured to impart an appearance of a traditional asphalt roofing module. In some embodiments, each of the roofing modules **810** is textured to impart an appearance of a photovoltaic module. In some embodiments, the roofing module **810** includes a coated surface **802**. In some embodiments, the roofing module **810** includes an embossed surface **802**. In some embodiments, the embossed surface **802** is embossed in register. In some embodiments, the embossed surface **802** is a mechanical embossed surface, a laser embossed surface, a thermo-mechanical embossed surface, or any combination thereof. In some embodiments, the roofing module **810** includes an etched surface **802**. In some embodiments, the

surface **802** includes a plurality of indentations **804**. In some embodiments, the indentations **804** includes a plurality of channels. In some embodiments, the plurality of channels is formed in a pattern. In some embodiments, each of the plurality of channels is random in size, shape and location. In some embodiments, the surface **802** includes a matte surface texture. In some
5 embodiments, the surface **802** includes a glossy surface, such as a shiny film, gloss patterned glass, or a gloss non-patterned glass. In some embodiments, the surface **802** includes ink. In some embodiments, the ink is printed, on the surface **802**, in a pattern. In some embodiments, the ink is printed in the pattern by an inkjet printer. In some embodiments, the ink is printed in the pattern by an offset printer. In some embodiments, the ink is printed in the pattern by a rotogravure printer.
10 In some embodiments, the ink is printed in the pattern by a flexographic printer. In some embodiments, the ink is printed in the pattern by a screen printer.

In some embodiments, the surface **802** has a surface roughness, R_a . In some embodiments, the surface **802** has a surface roughness of 0.01 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of 0.01 μm to 90 μm . In some embodiments, the surface **802** has a
15 surface roughness of 0.01 μm to 80 μm . In some embodiments, the surface **802** has a surface roughness of 0.01 μm to 70 μm . In some embodiments, the surface **802** has a surface roughness of 0.01 μm to 60 μm . In some embodiments, the surface **802** has a surface roughness of 0.01 μm to 50 μm . In some embodiments, the surface **802** has a surface roughness of 0.01 μm to 40 μm . In some embodiments, the surface **802** has a surface roughness of 0.01 μm to 30 μm . In some
20 embodiments, the surface **802** has a surface roughness of 0.01 μm to 20 μm . In some embodiments, the surface **802** has a surface roughness of 0.01 μm to 10 μm . In some embodiments, the surface **802** has a surface roughness of 0.01 μm to 5 μm . In some embodiments, the surface **802** has a

surface roughness of 0.01 μm to 1 μm . In some embodiments, the surface **802** has a surface roughness of 0.01 μm to 0.1 μm .

In some embodiments, the surface **802** has a surface roughness of 0.1 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of 1 μm to 100 μm . In some
5 embodiments, the surface **802** has a surface roughness of 5 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of 10 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of 20 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of 30 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of 40 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of
10 50 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of 60 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of 70 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of 80 μm to 100 μm . In some embodiments, the surface **802** has a surface roughness of 90 μm to 100 μm .

FIG. 12B shows an embodiment of a coated surface **802** which is textured to impart an
15 appearance of a photovoltaic module. In some embodiments, the coated surface **802** includes a coating. In some embodiments, the coating is a heat-cured coating. In some embodiments, the coating is an ionizing radiation-cured coating. In some embodiments, the coating is an ultraviolet light (UV)-cured coating. In some embodiments, the coating is a photothermally-cured coating. In some embodiments, the coating is at least two of a heat-cured coating, an ionizing radiation-
20 cured coating, a UV-cured coating, or a photothermally-cured coating. In some embodiments, the coating does not comprise asphalt.

In some embodiments, the coating includes at least one polymer. In some embodiments, the at least one polymer includes at least one of a thermoplastic polymer, a fluoropolymer, or any

combination thereof. In some embodiments, the thermoplastic polymer comprises a thermoplastic polyolefin. In some embodiments, the thermoplastic polyolefin comprises at least one of polyethylene, polypropylene, any copolymer thereof, any homopolymer thereof, any polymer blend thereof, or any combination thereof. In some embodiments, the thermoplastic polyolefin
5 comprises at least one of a copolymer of propylene and ethylene, a blend of propylene and ethylene, a copolymer of ethylene α -olefin, a propylene homopolymer, an ethylene homopolymer, a propylene block copolymer, an ethylene block copolymer, a propylene elastomer, an ethylene elastomer, or any combination thereof. In some embodiments, the thermoplastic polymer comprises at least one of a copolymer comprising ethylene and octene, a copolymer
10 comprising ethylene and hexane, a copolymer comprising ethylene and butene, polyethylene (including raw and/or recycled low density polyethylene (LDPE)), linear low density polyethylene (LLDPE), high density polyethylene (HDPE)), polypropylenes (e.g., isotactic polypropylene (IPP) and/or atactic polypropylene (APP/IPP)), amorphous polyalpha olefins (APAO), amorphous polyolefins (APO), or any combination thereof. In some embodiments, the fluoropolymer includes
15 at least one of ethylene tetrafluoroethylene (ETFE), polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), polyvinyl fluoride (PVF), or any combination thereof.

In some embodiments, the coating includes at least one of a colorant, a pigment, a dye, a
20 gloss control additive, or any combination thereof. In some embodiments, the pigment includes a reflective pigment. In some embodiments, the pigment includes an infrared reflective pigment, a near infrared reflective pigment, or any combination thereof. In some embodiments, the coating includes a metal oxide. In some embodiments, the metal oxide includes at least one of a transition

metal oxide, an alkali metal oxide, an alkali metal silicate, or any combination thereof. In some embodiments, the coating includes at least one of titanium dioxide white, carbon black, lampblack, black iron oxide, red iron oxide, yellow iron oxide, brown iron oxide (a blend of red and yellow oxide with black), phthalocyanine green, Colonial red, phthalocyanine blue, naphthol red, quinacridone red, toulidine red, quinacridone magenta, quinacridone violet, DNA orange, Hansa yellow, and the like.

In some embodiments, the coating includes a surfacing media. In some embodiments, the surfacing media includes mineral particles. In some embodiments, the surfacing media includes a plurality of fines. In some embodiments, the surfacing media includes at least one of slag fines, granule fines, sands, limestone fines, calcium carbonate, slate fines, or any combination thereof. In some embodiments, the surfacing media includes at least one of granite, basalt, clay, coal, gypsum limestone, marble, quartz, rhyolite, sandstone, or any combination thereof.

FIG. 12C shows an embodiment of a PVDF coating **812** textured to impart an appearance of a photovoltaic module. **FIG. 12D** shows an embodiment of a surface media-containing coating **812** textured to impart an appearance of a photovoltaic module.

In some embodiments, the roofing module **810** is cuttable. In some embodiments, the roofing module **810** is cuttable to a desired size and shape.

FIG. 13 shows an embodiment of a roofing module **910**. In some embodiments, the roofing module **910** includes a layer **912** and an encapsulant **914** encapsulating the layer **912**. In some embodiments, the encapsulant **914** includes a first layer **914a** and a second layer **914b**. In some embodiments, the first layer **914a** is a UV blocking encapsulant layer. In some embodiments, the first layer **914a** is a non-UV blocking encapsulant layer. In some embodiments, the layer **912** includes a structure and/or is made from materials similar to those of the first layer **112**. In some

embodiments, the layer **912** includes polyethylene terephthalate (PET). In another embodiment, the layer **912** includes thermoplastic polyolefin (TPO). In some embodiments, a pattern is printed on a first surface of the layer **912**. In some embodiments, a pattern or depiction of solar cells is printed on the first surface of the layer **912**. In some embodiments, the pattern or depiction of solar cells includes a depiction of a plurality of cell fingers. In some embodiments, the depiction of the plurality of cell fingers is similar in size, shape and grain pattern of the cell fingers **1340** described below.

In some embodiments, the roofing module **910** includes a frontsheet **916**. In some embodiments, the frontsheet **916** includes glass. In some embodiments, the frontsheet **916** includes textured glass. In some embodiments, the frontsheet **916** is textured to impart an appearance of a traditional asphalt roofing module. In some embodiments, the frontsheet **916** includes a surface **917**. In some embodiments, the surface **917** is an embossed surface. In some embodiments, the surface **917** includes a plurality of indentations. In some embodiments, the indentations includes a plurality of channels. In some embodiments, the plurality of channels is formed in a pattern. In some embodiments, each of the plurality of channels is random in size, shape and location. In some embodiments, the surface **917** includes a matte surface texture. In some embodiments, the surface **917** includes a glossy surface, such as a shiny film, gloss patterned glass, or a gloss non-patterned glass.

In some embodiments, the roofing module **910** includes a backsheet **928**. In some embodiments, the backsheet **928** is made from materials similar to those of the backsheet **28**. In some embodiments, the backsheet **928** is made from thermoplastic polyolefin (TPO).

In some embodiments, the roofing module **910** is cuttable. In some embodiments, the roofing module **910** is cuttable to a desired size and shape.

FIG. 14 shows an embodiment of a roofing module **1010**. The roofing module **1010** includes a structure and function similar to the roofing module **210**, except for certain differences described hereinafter. In some embodiments, the frontsheet **1016** includes glass. In some embodiments, the frontsheet **1016** includes textured glass. In some embodiments, the frontsheet **1016** is textured to impart an appearance of a traditional asphalt roofing module. In some embodiments, the frontsheet **1016** includes a surface **1017**. In some embodiments, the surface **1017** is an embossed surface. In some embodiments, the surface **1017** includes a plurality of indentations. In some embodiments, the indentations includes a plurality of channels. In some embodiments, the plurality of channels is formed in a pattern. In some embodiments, each of the plurality of channels is random in size, shape and location. In some embodiments, the surface **1017** includes a matte surface texture. In some embodiments, the surface **1017** includes a glossy surface, such as a shiny film, gloss patterned glass, or a gloss non-patterned glass.

In some embodiments, the roofing module **1010** includes an encapsulant layer **1014** and a backsheet **1028**. In some embodiments, the backsheet **1028** is made from materials similar to those of the backsheet **228**. In some embodiments, the backsheet **1028** is made from thermoplastic polyolefin (TPO). In some embodiments, a pattern is printed on a first surface of the backsheet **1028**. In some embodiments, a pattern or depiction of solar cells is printed on the first surface of the backsheet **1028**. In some embodiments, the pattern or depiction of solar cells includes a depiction of a plurality of cell fingers. In some embodiments, the depiction of the plurality of cell fingers is similar in size, shape and grain pattern of the cell fingers **1340** described below. In another embodiment, the backsheet **1028** is painted. In another embodiment, the backsheet **1028** is black in color.

In some embodiments, the roofing module **1010** is cuttable. In some embodiments, the roofing module **1010** is cuttable to a desired size and shape.

FIG. 15 shows an embodiment of a photovoltaic module **1110**. In some embodiments, the photovoltaic module **1110** includes at least one solar cell **1112**, an encapsulant **1114** encapsulating
5 the at least one solar cell **1112**, a frontsheet **1116** juxtaposed with a first layer **1114a** of the encapsulant **1114**, and a backsheet **1128** juxtaposed with a second layer **1114b** of the encapsulant **1114**. In some embodiments, the frontsheet **1116** includes glass. In some embodiments, the at least one solar cell **1112** includes a plurality of solar cells. In some embodiments, the frontsheet **1116** includes textured glass. In some embodiments, the frontsheet **1116** is textured to impart an
10 appearance of a traditional asphalt roofing module. In some embodiments, the frontsheet **1116** includes a surface **1117**. In some embodiments, the surface **1117** is an embossed surface. In some embodiments, the surface **1117** includes a plurality of indentations. In some embodiments, the indentations includes a plurality of channels. In some embodiments, the plurality of channels is formed in a pattern. In some embodiments, each of the plurality of channels is random in size,
15 shape and location. In some embodiments, the surface **1117** includes a matte surface texture. In some embodiments, the surface **1117** includes a glossy surface, such as a shiny film, gloss patterned glass, or a gloss non-patterned glass.

In some embodiments, the backsheet **1128** is made from materials similar to those of the backsheet **228**. In some embodiments, the backsheet **1128** is made from thermoplastic polyolefin
20 (TPO). In another embodiment, the backsheet **1128** is painted. In another embodiment, the backsheet **1128** is black in color.

FIG. 16 and **17** show an embodiment of a roofing module **1210**. In some embodiments, the roofing module **1210** includes a first layer **1228** and a second layer **1230**. In some

embodiments, the first layer **1228** overlays the second layer **1230**. In some embodiments, the first layer **1228** is juxtaposed with the second layer **1230**. In some embodiments, the first layer **1228** and the second layer **1230** are thermally bonded to one another. In some embodiments, the first layer **1228** and the second layer **1230** are laminated. In some embodiments, the first layer **1228** is attached to the second layer **1230** by an adhesive. In some embodiments, the first layer **1228** and the second layer **1230** are mechanically attached to one another. In some embodiments, the roofing module **1210** does not include a solar cell, a photovoltaic cell, or any electrical device that converts the energy of light into electricity. In some embodiments, the roofing module **1210** does not include any electrically active components.

In some embodiments, the first layer **1228** is composed of a polymeric material. In some embodiments, the first layer **1228** is composed of polyethylene terephthalate (“PET”). In another embodiment, the first layer **1228** is composed of ethylene tetrafluoroethylene (“ETFE”). In some embodiments, the first layer **1228** is composed of an acrylic such as polymethyl methacrylate (“PMMA”). In some embodiments, the first layer **1228** is composed of thermoplastic polyolefin (TPO). In some embodiments, the first layer **1228** is composed of a single ply TPO roofing membrane. In other embodiments, non-limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is incorporated by reference herein in its entirety. In another embodiment, the first layer **1228** is composed of includes polyvinyl chloride. In some embodiments, the first layer **1228** is composed of ethylene propylene diene monomer (EPDM) rubber. In some embodiments, the first layer **1228** includes a flame retardant additive. In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof. In some embodiments, the first layer **1228** is composed of a UV resistant material. In some embodiments,

the first layer **1228** includes a UV resistant coating. In some embodiments, the first layer **1228** is composed of a water resistant material.

In some embodiments, the second layer **1230** is composed of a polymeric material. In some embodiments, the second layer **1230** is composed of polyethylene terephthalate (“PET”). In another embodiment, the second layer **1230** is composed of ethylene tetrafluoroethylene (“ETFE”). In some embodiments, the second layer **1230** is composed of an acrylic such as polymethyl methacrylate (“PMMA”). In some embodiments, the second layer **1230** is composed of thermoplastic polyolefin (TPO). In some embodiments, the second layer **1230** is composed of a single ply TPO roofing membrane. In other embodiments, non-limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is incorporated by reference herein in its entirety. In another embodiment, the second layer **1230** is composed of includes polyvinyl chloride. In some embodiments, the second layer **1230** of ethylene propylene diene monomer (EPDM) rubber. In some embodiments, the second layer **1230** includes a flame retardant additive. In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof. In some embodiments, the second layer **1230** is composed of a UV resistant material. In some embodiments, the second layer **1230** is composed of a water resistant material. In some embodiments, the second layer **1230** is composed of a polymer with fiberglass.

In some embodiments, the first layer **1228** has a thickness of 25 mils to 100 mils. In some embodiments, the first layer **1228** has a thickness of 25 mils to 90 mils. In some embodiments, the first layer **1228** has a thickness of 25 mils to 80 mils. In some embodiments, the first layer **1228** has a thickness of 25 mils to 70 mils. In some embodiments, the first layer **1228** has a thickness of 25 mils to 60 mils. In some embodiments, the first layer **1228** has a thickness of 25

mils to 50 mils. In some embodiments, the first layer **1228** has a thickness of 25 mils to 40 mils. In some embodiments, the first layer **1228** has a thickness of 25 mils to 30 mils. In some embodiments, the first layer **1228** has a thickness of 30 mils to 100 mils. In some embodiments, the first layer **1228** has a thickness of 30 mils to 90 mils. In some embodiments, the first layer **1228** has a thickness of 30 mils to 80 mils. In some embodiments, the first layer **1228** has a thickness of 30 mils to 70 mils. In some embodiments, the first layer **1228** has a thickness of 30 mils to 60 mils. In some embodiments, the first layer **1228** has a thickness of 30 mils to 50 mils. In some embodiments, the first layer **1228** has a thickness of 30 mils to 40 mils.

In some embodiments, the first layer **1228** has a thickness of 40 mils to 100 mils. In some embodiments, the first layer **1228** has a thickness of 40 mils to 90 mils. In some embodiments, the first layer **1228** has a thickness of 40 mils to 80 mils. In some embodiments, the first layer **1228** has a thickness of 40 mils to 70 mils. In some embodiments, the first layer **1228** has a thickness of 40 mils to 60 mils. In some embodiments, the first layer **1228** has a thickness of 40 mils to 50 mils. In some embodiments, the first layer **1228** has a thickness of 50 mils to 100 mils. In some embodiments, the first layer **1228** has a thickness of 50 mils to 90 mils. In some embodiments, the first layer **1228** has a thickness of 50 mils to 80 mils. In some embodiments, the first layer **1228** has a thickness of 50 mils to 70 mils. In some embodiments, the first layer **1228** has a thickness of 50 mils to 60 mils.

In some embodiments, the first layer **1228** has a thickness of 60 mils to 100 mils. In some embodiments, the first layer **1228** has a thickness of 60 mils to 90 mils. In some embodiments, the first layer **1228** has a thickness of 60 mils to 80 mils. In some embodiments, the first layer **1228** has a thickness of 60 mils to 70 mils. In some embodiments, the first layer **1228** has a thickness of 70 mils to 100 mils. In some embodiments, the first layer **1228** has a thickness of 70

mils to 90 mils. In some embodiments, the first layer **1228** has a thickness of 70 mils to 80 mils. In some embodiments, the first layer **1228** has a thickness of 80 mils to 100 mils. In some embodiments, the first layer **1228** has a thickness of 80 mils to 90 mils. In some embodiments, the first layer **1228** has a thickness of 90 mils to 100 mils.

5 In some embodiments, the first layer **1228** has a thickness of 25 mils. In some
embodiments, the first layer **1228** has a thickness of 30 mils. In some embodiments, the first layer
1228 has a thickness of 40 mils. In some embodiments, the first layer **1228** has a thickness of 50
mils. In some embodiments, the first layer **1228** has a thickness of 60 mils. In some
embodiments, the first layer **1228** has a thickness of 70 mils. In some embodiments, the first layer
10 **1228** has a thickness of 80 mils. In some embodiments, the first layer **1228** has a thickness of 90
mils. In some embodiments, the first layer **1228** has a thickness of 100 mils.

In some embodiments, the second layer **1230** has a thickness of 25 mils to 200 mils. In
some embodiments, the second layer **1230** has a thickness of 25 mils to 200 mils. In some
embodiments, the second layer **1230** has a thickness of 25 mils to 200 mils. In some embodiments,
the second layer 1230 has a thickness of 25 mils to 200 mils. In some embodiments, the second
layer **1230** has a thickness of 25 mils to 200 mils. In some embodiments, the second layer **1230**
has a thickness of 25 mils to 200 mils. In some embodiments, the second layer **1230** has a thickness
of 25 mils to 200 mils. In some embodiments, the second layer **1230** has a thickness of 25 mils to
200 mils. In some embodiments, the second layer **1230** has a thickness of 25 mils to 200 mils. In
some embodiments, the second layer **1230** has a thickness of 25 mils to 200 mils. In some
embodiments, the second layer **1230** has a thickness of 25 mils to 200 mils. In some embodiments,
the second layer **1230** has a thickness of 25 mils to 200 mils. In some embodiments, the second
layer **1230** has a thickness of 25 mils to 200 mils. In some embodiments, the second layer **1230**

has a thickness of 25 mils to 200 mils. In some embodiments, the second layer **1230** has a thickness of 25 mils to 200 mils. In some embodiments, the second layer **1230** has a thickness of 25 mils to 200 mils. In some embodiments, the second layer **1230** has a thickness of 25 mils to 200 mils. In some
5 embodiments, the second layer **1230** has a thickness of 40 mils to 200 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 190 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 180 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 170 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 160 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to
10 150 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 140 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 130 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 120 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 110 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 100 mils. In some embodiments, the second layer **1230**
15 has a thickness of 40 mils to 90 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 80 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 70 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils to 60 mils.

In some embodiments, the second layer **1230** has a thickness of 60 mils to 200 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 190 mils. In some
20 embodiments, the second layer **1230** has a thickness of 60 mils to 180 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 170 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 160 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 150 mils. In some embodiments, the second layer **1230** has a thickness

of 60 mils to 140 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 130 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 120 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 110 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 100 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 90 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 80 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils to 70 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 200 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 190 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 180 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 170 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 160 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 150 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 140 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 130 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 120 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 110 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 100 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils to 90 mils.

In some embodiments, the second layer **1230** has a thickness of 100 mils to 200 mils. In some embodiments, the second layer **1230** has a thickness of 100 mils to 190 mils. In some embodiments, the second layer **1230** has a thickness of 100 mils to 180 mils. In some embodiments, the second layer **1230** has a thickness of 100 mils to 170 mils. In some embodiments, the second layer **1230** has a thickness of 100 mils to 160 mils. In some embodiments, the second layer **1230** has a thickness of 100 mils to 150 mils. In some

embodiments, the second layer **1230** has a thickness of 100 mils to 140 mils. In some
embodiments, the second layer **1230** has a thickness of 100 mils to 130 mils. In some
embodiments, the second layer **1230** has a thickness of 100 mils to 120 mils. In some
embodiments, the second layer **1230** has a thickness of 100 mils to 110 mils. In some
5 embodiments, the second layer **1230** has a thickness of 120 mils to 200 mils. In some
embodiments, the second layer **1230** has a thickness of 120 mils to 190 mils. In some
embodiments, the second layer **1230** has a thickness of 120 mils to 180 mils. In some
embodiments, the second layer **1230** has a thickness of 120 mils to 170 mils. In some
embodiments, the second layer **1230** has a thickness of 120 mils to 160 mils. In some
10 embodiments, the second layer **1230** has a thickness of 120 mils to 150 mils. In some
embodiments, the second layer **1230** has a thickness of 120 mils to 140 mils. In some
embodiments, the second layer **1230** has a thickness of 120 mils to 130 mils.

In some embodiments, the second layer **1230** has a thickness of 140 mils to 200 mils. In
some embodiments, the second layer **1230** has a thickness of 140 mils to 190 mils. In some
15 embodiments, the second layer **1230** has a thickness of 140 mils to 180 mils. In some
embodiments, the second layer **1230** has a thickness of 140 mils to 170 mils. In some
embodiments, the second layer **1230** has a thickness of 140 mils to 160 mils. In some
embodiments, the second layer **1230** has a thickness of 140 mils to 150 mils. In some
embodiments, the second layer **1230** has a thickness of 160 mils to 200 mils. In some
20 embodiments, the second layer **1230** has a thickness of 160 mils to 190 mils. In some
embodiments, the second layer **1230** has a thickness of 160 mils to 180 mils. In some
embodiments, the second layer **1230** has a thickness of 160 mils to 170 mils. In some

embodiments, the second layer **1230** has a thickness of 180 mils to 200 mils. In some embodiments, the second layer **1230** has a thickness of 180 mils to 190 mils.

In some embodiments, the second layer **1230** has a thickness of 25 mils. In some embodiments, the second layer **1230** has a thickness of 30 mils. In some embodiments, the second layer **1230** has a thickness of 40 mils. In some embodiments, the second layer **1230** has a thickness of 50 mils. In some embodiments, the second layer **1230** has a thickness of 60 mils. In some embodiments, the second layer **1230** has a thickness of 70 mils. In some embodiments, the second layer **1230** has a thickness of 80 mils. In some embodiments, the second layer **1230** has a thickness of 90 mils. In some embodiments, the second layer **1230** has a thickness of 100 mils. In some embodiments, the second layer **1230** has a thickness of 110 mils. In some embodiments, the second layer **1230** has a thickness of 120 mils. In some embodiments, the second layer **1230** has a thickness of 130 mils. In some embodiments, the second layer **1230** has a thickness of 140 mils. In some embodiments, the second layer **1230** has a thickness of 150 mils. In some embodiments, the second layer **1230** has a thickness of 160 mils. In some embodiments, the second layer **1230** has a thickness of 170 mils. In some embodiments, the second layer **1230** has a thickness of 180 mils. In some embodiments, the second layer **1230** has a thickness of 190 mils. In some embodiments, the second layer **1230** has a thickness of 200 mils.

In some embodiments, the roofing module **1210** is textured. In some embodiments, the roofing module **1210** is textured to impart an appearance of a traditional asphalt roofing shingle. In some embodiments, the first layer **1228** includes a first surface **1250**. In some embodiments, first surface **1250** is embossed. In some embodiments, the first surface **1250** includes a plurality of indentations. In some embodiments, the plurality of indentations includes a plurality of channels. In some embodiments, the plurality of channels is formed in a pattern. In some

embodiments, each of the plurality of channels is random in size, shape and location. In some embodiments, the first surface **1250** includes a matte surface texture. In some embodiments, the first surface **1250** includes a glossy surface.

In some embodiments, the first surface **1250** of the first layer **1228** is textured. In some
5 embodiments, the first surface **1250** of the first layer **1228** is textured by embossing. In some
embodiments, the first surface **1250** of the first layer **1228** is textured. In some embodiments, the
first surface **1250** of the first layer **1228** is textured by molding. In some embodiments, the first
surface **1250** of the first layer **1228** is textured. In some embodiments, the first surface **1250** of
the first layer **1228** is textured by etching. In some embodiments, the first surface **1250** of the first
10 layer **1228** is textured. In some embodiments, the first surface **1250** of the first layer **1228** is
textured by laser surface texturing.

In some embodiments, a pattern is printed on a first surface **1250** of the first layer **1228**.
In some embodiments, a pattern or depiction of solar cells is printed on the first surface **1250** of
the first layer **1228**. In some embodiments, the pattern or depiction of solar cells includes a
15 depiction of a plurality of cell fingers. In some embodiments, the depiction of the plurality of cell
fingers is similar in size, shape and grain pattern of the cell fingers **1340** described below. In some
embodiments, the pattern is printed on the first surface **1250** of the first layer **1228** by ink jet
printing. In some embodiments, the pattern is printed on the first surface **1250** of the first layer
1228 by laser printing. In some embodiments, the pattern is printed on the first surface **1250** of
20 the first layer **1228** by lithography. In some embodiments, the pattern is printed on the first surface
1250 of the first layer **1228** by lithography. In some embodiments, the pattern is printed on the
first surface **1250** of the first layer **1228** by offset printing. In some embodiments, the pattern is
printed on the first surface **1250** of the first layer **1228** by screen printing. In some embodiments,

the pattern is printed on the first surface **1250** of the first layer **1228** by digital printing. In another embodiment, the first layer **1228** is painted. In another embodiment, the first layer **1228** is a colored layer. In another embodiment, the first layer **1228** includes a black color. In some embodiments, the color of the first layer **1228** includes a mixture of colors. In some embodiments, the first layer **1228** includes an infrared reflective pigment. In some embodiments, the infrared reflective pigment includes graphene. In some embodiments, the roofing module **1210** meets standards of California Building Energy Efficiency Standards of Residential and Nonresidential Buildings, Title 24, Part 6. In some embodiments, the first surface **1250** of the first layer **1228** is textured and includes a pattern printed thereon.

In some embodiments, the roofing module **1210** is configured to be a component of a photovoltaic system that includes a fire resistance that conforms to standards under UL 790/ASTM E 108 test standards. In some embodiments, the roofing module **1210** includes a Class A rating when tested in accordance with UL 790/ASTM E 108.

Referring to **FIG. 18**, in some embodiments, a photovoltaic module **1310** includes at least one solar cell **1312**, an encapsulant **1314** encapsulating the at least one solar cell **1312**, and a frontsheet **1316** juxtaposed with the encapsulant **1314**. As used herein, the terms “encapsulating” and “encapsulates” mean to partially or fully envelope or enclose, and with respect to certain embodiments of the photovoltaic module **1310**, the at least one solar cell **1312** is fully enveloped by or enclosed within the encapsulant **1314**, or partially enveloped by or enclosed within the encapsulant **1314**. In some embodiments, the encapsulant **1314** includes a first layer **1314a** and a second layer **1314b**.

In some embodiments, the at least one solar cell **1312** includes a plurality of the solar cells **1312**. In some embodiments, the encapsulant **1314** encapsulates the plurality of solar cells **1312**.

In some embodiments, the at least one solar cell **1312** is electrically inactive (i.e., a “dummy” solar cell). In some embodiments, the plurality of solar cells **1312** is arranged in one row (i.e., one reveal). In another embodiment, the plurality of solar cells **1312** is arranged in two rows (i.e., two reveals). In another embodiment, the plurality of solar cells **1312** is arranged in three rows (i.e., three reveals). In other embodiments, the plurality of solar cells **1312** is arranged in more than three rows.

In some embodiments, the encapsulant **1314** may be made from polyolefins, ethyl vinyl acetates, ionomers, silicones, poly vinyl butyral, epoxies, polyurethanes, or combinations/hybrids thereof. In some embodiments, the encapsulant **1314** is made from thermosetting polyolefin. In some embodiments, the encapsulant **1314** includes a thickness of 0.4 mm to 1.8 mm. In some embodiments, the first layer **1314a** of the encapsulant **1314** includes a thickness of 0.2 mm to 0.9 mm. In some embodiments, the second layer **1314b** of the encapsulant **1314** includes a thickness of 0.2 mm to 0.9 mm.

In some embodiments, the thickness of the first layer **1314a** is equal to the thickness of the second layer **1314b**. In another embodiment, the thickness of the first layer **1314a** is different from the thickness of the second layer **1314b**. In some embodiments, the frontsheet **1316** includes a glass layer **1318** and a polymer layer **1320** attached to the glass layer **1318**. In some embodiments, the frontsheet **1316** is juxtaposed with the first layer **1314a** of the encapsulant **1314**. In some embodiments, each of the glass layer **1318** and the polymer layer **1320** is transparent. In some embodiments, the glass layer **1318** includes a thickness of 2.5 mm to 4 mm.

In some embodiments, the polymer layer **1320** is attached to the glass layer **1318** by an adhesive layer **1322**. In some embodiments, the adhesive layer **1322** may include polyvinyl butyrate, acrylic, silicone, or polycarbonate. In another embodiment, the adhesive layer **1322** may

include pressure sensitive adhesives. In another embodiment, the polymer layer **1320** is attached to the glass layer **1318** by thermal bonding. In another embodiment, the frontsheet **1316** includes at least one of the glass layer **1318** or the polymer layer **1320**.

In some embodiments, the adhesive layer **1322** includes thermosetting polyolefin, thermosetting polyolefin encapsulant material, thermosetting ethylene-vinyl acetate (EVA), EVA encapsulants, thermoplastic olefin, thermoplastic polyolefin (TPO) or hybrids/combinations thereof. In some embodiments, the adhesive layer **1322** includes a thickness of 1 μm to 900 μm .

In some embodiments, the polymer layer **1320** includes a fluoropolymer. In certain embodiments, the fluoropolymer may be ethylene tetrafluoroethylene (ETFE), fluoropolymer is polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), and tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), polyvinyl fluoride (PVF), or blends thereof. In some embodiments, the frontsheet includes fluoropolymers, acrylics, polyesters, silicones, polycarbonates, or combinations thereof. In other embodiments, the polymer layer **1320** includes polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyaryletherketone (PAEK), polyarylate (PAR), polyetherimide (PEI), polyarylsulfone (PAS), polyethersulfone (PES), polyamideimide (PAI), polyphenylsulfone (PPSU), polyolefin, cyclic olefin copolymers (CPCs), or polyimide. In some embodiments, the polymer layer **1320** includes a crosslinked polymeric material. In some embodiments, 50% to 99% of the polymer chains of the polymeric material are crosslinked. In some embodiments, the polymer layer **1320** includes a thickness of 0.01 mm to 0.5 mm.

In some embodiments, a backsheet **1324** is juxtaposed with the second layer **1314b** of the encapsulant **1314**. In some embodiments, the backsheet **1324** includes thermoplastic polyolefin (TPO). In some embodiments, the backsheet **1324** includes a single ply TPO roofing membrane.

In other embodiments, non-limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is incorporated by reference herein in its entirety. In another embodiment, the backsheet **1324** includes polyvinyl chloride. In some embodiments, the backsheet **1324** includes ethylene propylene diene monomer (EPDM) rubber. In some
5 embodiments, the backsheet **1324** includes a flame retardant additive. In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof.

In some embodiments, the photovoltaic module **1310** is flexible. As used herein, the term “flexible” means capable of bending without breaking or elastic deformation, and with respect to
10 certain embodiments of the photovoltaic module **1310**, the photovoltaic module **1310** is capable of being bent without breakage or elastic deformation of any of the layers thereof, i.e., any of the layers of the frontsheet **1316**, the backsheet **1324**, and the encapsulant **1314**.

In some embodiments, the frontsheet **1316** is unpainted. In some embodiments, the backsheet **1324** is unpainted. In some embodiments, none of the layers of the photovoltaic module
15 **1310** is painted. In some embodiments, the frontsheet **1316** and the backsheet **1324** are unpainted.

In some embodiments, a liner **1326** is configured to form a plurality of indentations within the frontsheet **1316**. In some embodiments, the plurality of indentations is formed within the polymer layer **1320** and the adhesive layer **1322**. In some embodiments, the liner **1326** is a textured release liner including a plurality of dimples configured to form the plurality of indentations in the
20 frontsheet **1316**. In some embodiments, the photovoltaic module **1310** is laminated. In some embodiments, the liner **1326** is configured to form the plurality of indentations within the frontsheet **1316** during lamination of the photovoltaic module **1310**. In some embodiments, the liner **1326** is removed after formation of the plurality of indentations.

In some embodiments, the liner **1326** includes a thickness of 0.025 mm to 5 mm. In another embodiment, the liner **1326** includes a thickness of 0.025 mm to 4 mm. In another embodiment, the liner **1326** includes a thickness of 0.025 mm to 3 mm. In another embodiment, the liner **1326** includes a thickness of 0.025 mm to 2 mm. In another embodiment, the liner **1326** includes a thickness of 0.025 mm to 1 mm. In another embodiment, the liner **1326** includes a thickness of 0.025 mm to 0.5 mm. In some embodiments, the liner **1326** includes a thickness of 0.5 mm to 5 mm. In another embodiment, the liner **1326** includes a thickness of 0.5 mm to 4 mm. In another embodiment, the liner **1326** includes a thickness of 0.5 mm to 3 mm. In another embodiment, the liner **1326** includes a thickness of 0.5 mm to 2 mm. In another embodiment, the liner **1326** includes a thickness of 0.5 mm to 1 mm.

In some embodiments, the liner **1326** includes a thickness of 1 mm to 5 mm. In another embodiment, the liner **1326** includes a thickness of 1 mm to 5 mm. In another embodiment, the liner **1326** includes a thickness of 1 mm to 4 mm. In another embodiment, the liner **1326** includes a thickness of 1 mm to 3 mm. In another embodiment, the liner **1326** includes a thickness of 1 mm to 2 mm. In some embodiments, the liner **1326** includes a thickness of 2 mm to 5 mm. In another embodiment, the liner **1326** includes a thickness of 2 mm to 4 mm. In another embodiment, the liner **1326** includes a thickness of 2 mm to 3 mm. In some embodiments, the liner **1326** includes a thickness of 3 mm to 5 mm. In another embodiment, the liner **1326** includes a thickness of 3 mm to 4 mm. In another embodiment, the liner **1326** includes a thickness of 4 mm to 5 mm.

FIGS. 19A through **19C** show embodiments of the liner **1326**. In some embodiments, **FIG. 19A** shows a liner **1328** including a plurality of dimples (i.e., indentations) **1330** formed within a surface thereof. In some embodiments, each of the dimples **1330** includes a length of

0.95 mm to 1.1 mm. In some embodiments, a majority of the dimples **1330** have a length of 0.95 mm to 1.1 mm. In some embodiments, each of the dimples **1330** includes a length of 0.95 mm to 1.05 mm. In some embodiments, each of the dimples **1330** includes a length of 0.95 mm to 1 mm. In some embodiments, each of the dimples **1330** includes a length of 1 mm to 1.1 mm. In some
5 embodiments, each of the dimples **1330** includes a length of 1 mm to 1.05 mm. In some
embodiments, each of the dimples **1330** includes a length of 1.05 mm to 1.1 mm.

In some embodiments, each of the dimples **1330** includes a length of 0.95 mm. In some
embodiments, each of the dimples **1330** includes a length of 0.96 mm. In some embodiments,
each of the dimples **1330** includes a length of 0.97 mm. In some embodiments, each of the dimples
10 **1330** includes a length of 0.98 mm. In some embodiments, each of the dimples **1330** includes a
length of 0.99 mm. In some embodiments, each of the dimples **1330** includes a length of 1 mm.
In some embodiments, each of the dimples **1330** includes a length of 1.01 mm. In some
embodiments, each of the dimples **1330** includes a length of 1.02 mm. In some embodiments,
each of the dimples **1330** includes a length of 1.03 mm. In some embodiments, each of the dimples
15 **1330** includes a length of 1.04 mm. In some embodiments, each of the dimples **1330** includes a
length of 1.05 mm. In some embodiments, each of the dimples **1330** includes a length of 1.06 mm.
In some embodiments, each of the dimples **1330** includes a length of 1.07 mm. In some
embodiments, each of the dimples **1330** includes a length of 1.08 mm. In some embodiments,
each of the dimples **1330** includes a length of 1.09 mm. In some embodiments, each of the dimples
20 **1330** includes a length of 1.1 mm.

In some embodiments, each of the dimples **1330** includes a width of 1.95 mm to 2.1 mm.
In some embodiments, a majority of the dimples **1330** have a width of 1.95 mm to 2.1 mm. In
some embodiments, each of the dimples **1330** includes a width of 1.95 mm to 2 mm. In some

embodiments, each of the dimples **1330** includes a width of 2 mm to 2.1 mm. In some embodiments, each of the dimples **1330** includes a width of 1.95 mm. In some embodiments, each of the dimples **1330** includes a width of 1.96 mm. In some embodiments, each of the dimples **1330** includes a width of 1.97 mm. In some embodiments, each of the dimples **1330** includes a width of 1.98 mm. In some embodiments, each of the dimples **1330** includes a width of 1.99 mm. In some embodiments, each of the dimples **1330** includes a width of 2 mm. In some embodiments, each of the dimples **1330** includes a width of 2.01 mm. In some embodiments, each of the dimples **1330** includes a width of 2.02 mm. In some embodiments, each of the dimples **1330** includes a width of 2.03 mm. In some embodiments, each of the dimples **1330** includes a width of 2.04 mm. In some embodiments, each of the dimples **1330** includes a width of 2.05 mm. In some embodiments, each of the dimples **1330** includes a width of 2.06 mm. In some embodiments, each of the dimples **1330** includes a width of 2.07 mm. In some embodiments, each of the dimples **1330** includes a width of 2.08 mm. In some embodiments, each of the dimples **1330** includes a width of 2.09 mm. In some embodiments, each of the dimples **1330** includes a width of 2.1 mm.

In some embodiments, each of the dimples **1330** includes a depth of 0.12 mm to 0.2 mm. In some embodiments, a majority of the dimples **1330** have a depth of 0.12 mm to 0.2 mm. In some embodiments, each of the dimples **1330** includes a depth of 0.12 mm to 0.19 mm. In some embodiments, each of the dimples **1330** includes a depth of 0.12 mm to 0.18 mm. In some embodiments, each of the dimples **1330** includes a depth of 0.12 mm to 0.17 mm. In some embodiments, each of the dimples **1330** includes a depth of 0.12 mm to 0.16 mm. In some embodiments, each of the dimples **1330** includes a depth of 0.12 mm to 0.15 mm. In some embodiments, each of the dimples **1330** includes a depth of 0.12 mm to 0.14 mm. In some embodiments, each of the dimples **1330** includes a depth of 0.12 mm to 0.13 mm.

In some embodiments, each of the dimples **1330** includes a depth of 0.13 mm to 0.2 mm.

In some embodiments, each of the dimples **1330** includes a depth of 0.13 mm to 0.19 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.13 mm to 0.18 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.13 mm to 0.17 mm. In some
5 embodiments, each of the dimples **1330** includes a depth of 0.13 mm to 0.16 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.13 mm to 0.15 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.13 mm to 0.14 mm.

In some embodiments, each of the dimples **1330** includes a depth of 0.14 mm to 0.2 mm.

In some embodiments, each of the dimples **1330** includes a depth of 0.14 mm to 0.19 mm. In some
10 embodiments, each of the dimples **1330** includes a depth of 0.14 mm to 0.18 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.14 mm to 0.17 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.14 mm to 0.16 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.14 mm to 0.15 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.15 mm to 0.2 mm. In some
15 embodiments, each of the dimples **1330** includes a depth of 0.15 mm to 0.19 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.15 mm to 0.18 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.15 mm to 0.17 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.15 mm to 0.16 mm.

In some embodiments, each of the dimples **1330** includes a depth of 0.16 mm to 0.2 mm.

20 In some embodiments, each of the dimples **1330** includes a depth of 0.16 mm to 0.19 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.16 mm to 0.18 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.16 mm to 0.17 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.17 mm to 0.2 mm. In some

embodiments, each of the dimples **1330** includes a depth of 0.17 mm to 0.19 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.17 mm to 0.18 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.18 mm to 0.2 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.18 mm to 0.19 mm. In some
5 embodiments, each of the dimples **1330** includes a depth of 0.19 mm to 0.2 mm.

In some embodiments, each of the dimples **1330** includes a depth of 0.12 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.13 mm. In some embodiments,
each of the dimples **1330** includes a depth of 0.14 mm. In some embodiments, each of the dimples
1330 includes a depth of 0.15 mm. In some embodiments, each of the dimples **1330** includes a
10 depth of 0.155 mm. In some embodiments, each of the dimples **1330** includes a depth of 0.16
mm. In some embodiments, each of the dimples **1330** includes a depth of 0.17 mm. In some
embodiments, each of the dimples **1330** includes a depth of 0.18 mm. In some embodiments,
each of the dimples **1330** includes a depth of 0.19 mm.

In some embodiments, the liner **1328** includes polytetrafluoroethylene (PTFE). In some
15 embodiments, the liner **1328** includes PTFE coated glass fabric. In some embodiments, the PTFE
coated glass fabric is Steinbach AG PTFE fabric 345. In some embodiments, the liner **1328** is
configured to form within the frontsheet **1316** a plurality of indentations having a size and shape
corresponding to those of the plurality of dimples **1330**.

In some embodiments, **FIG. 19B** shows a liner **1332** including a plurality of dimples **1334**
20 formed within a surface thereof. In some embodiments, each of the dimples **1334** includes a length
of 1.2 mm to 1.4 mm. In some embodiments, a majority of the dimples **1334** have a length of 1.2
mm to 1.4 mm. In some embodiments, each of the dimples **1334** includes a length of 1.2 mm to
1.3 mm. In some embodiments, each of the dimples **1334** includes a length of 1.3 mm to 1.4 mm.

In some embodiments, each of the dimples **1334** includes a length of 1.2 mm. In some embodiments, each of the dimples **1334** includes a length of 1.3 mm. In some embodiments, each of the dimples **1334** includes a length of 1.31 mm. In some embodiments, each of the dimples **1334** includes a length of 1.4 mm.

5 In some embodiments, each of the dimples **1334** includes a width of 2.85 mm to 2.95 mm. In some embodiments, a majority of the dimples **1334** have a width of 2.85 mm to 2.95 mm. In some embodiments, each of the dimples **1334** includes a width of 2.85 mm to 2.9 mm. In some embodiments, each of the dimples **1334** includes a width of 2.9 mm to 2.95 mm. In some embodiments, each of the dimples **1334** includes a width of 2.85 mm. In some embodiments, each
10 of the dimples **1334** includes a width of 2.9 mm. In some embodiments, each of the dimples **1334** includes a width of 2.95 mm.

 In some embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.28 mm. In some embodiments, a majority of the dimples **1334** have a depth of 0.17 mm to 0.28 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.27 mm. In some
15 embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.26 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.25 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.24 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.23 mm. In some
20 embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.22 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.21 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.2 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.19 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.17 mm to 0.18 mm.

In some embodiments, each of the dimples **1334** includes a depth of 0.18 mm to 0.28 mm.

In some embodiments, each of the dimples **1334** includes a depth of 0.18 mm to 0.27 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.18 mm to 0.26 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.18 mm to 0.25 mm. In some
5 embodiments, each of the dimples **1334** includes a depth of 0.18 mm to 0.24 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.18 mm to 0.23 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.18 mm to 0.22 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.18 mm to 0.21 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.18 mm to 0.2 mm. In some
10 embodiments, each of the dimples **1334** includes a depth of 0.18 mm to 0.19 mm.

In some embodiments, each of the dimples **1334** includes a depth of 0.19 mm to 0.28 mm.

In some embodiments, each of the dimples **1334** includes a depth of 0.19 mm to 0.27 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.19 mm to 0.26 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.19 mm to 0.25 mm. In some
15 embodiments, each of the dimples **1334** includes a depth of 0.19 mm to 0.24 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.19 mm to 0.23 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.19 mm to 0.22 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.19 mm to 0.21 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.19 mm to 0.2 mm.

20 In some embodiments, each of the dimples **1334** includes a depth of 0.2 mm to 0.28 mm.

In some embodiments, each of the dimples **1334** includes a depth of 0.2 mm to 0.27 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.2 mm to 0.26 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.2 mm to 0.25 mm. In some

embodiments, each of the dimples **1334** includes a depth of 0.2 mm to 0.24 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.2 mm to 0.23 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.2 mm to 0.22 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.2 mm to 0.21 mm.

5 In some embodiments, each of the dimples **1334** includes a depth of 0.21 mm to 0.28 mm.

In some embodiments, each of the dimples **1334** includes a depth of 0.21 mm to 0.27 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.21 mm to 0.26 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.21 mm to 0.25 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.21 mm to 0.24 mm. In some
10 embodiments, each of the dimples **1334** includes a depth of 0.21 mm to 0.23 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.21 mm to 0.22 mm.

In some embodiments, each of the dimples **1334** includes a depth of 0.22 mm to 0.28 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.22 mm to 0.27 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.22 mm to 0.26 mm. In some
15 embodiments, each of the dimples **1334** includes a depth of 0.22 mm to 0.25 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.22 mm to 0.24 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.22 mm to 0.23 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.23 mm to 0.28 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.23 mm to 0.27 mm. In some
20 embodiments, each of the dimples **1334** includes a depth of 0.23 mm to 0.26 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.23 mm to 0.25 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.23 mm to 0.24 mm.

In some embodiments, each of the dimples **1334** includes a depth of 0.24 mm to 0.28 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.24 mm to 0.27 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.24 mm to 0.26 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.24 mm to 0.25 mm. In some
5 embodiments, each of the dimples **1334** includes a depth of 0.25 mm to 0.28 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.25 mm to 0.27 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.25 mm to 0.26 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.26 mm to 0.28 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.26 mm to 0.27 mm. In some
10 embodiments, each of the dimples **1334** includes a depth of 0.27 mm to 0.28 mm.

In some embodiments, each of the dimples **1334** includes a depth of 0.17 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.18 mm. In some embodiments, each
of the dimples **1334** includes a depth of 0.19 mm. In some embodiments, each of the dimples **1334**
includes a depth of 0.2 mm. In some embodiments, each of the dimples **1334** includes a depth of
15 0.21 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.22 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.227 mm. In some embodiments,
each of the dimples **1334** includes a depth of 0.23 mm. In some embodiments, each of the dimples
1334 includes a depth of 0.24 mm. In some embodiments, each of the dimples **1334** includes a
depth of 0.25 mm. In some embodiments, each of the dimples **1334** includes a depth of 0.26 mm.
20 In some embodiments, each of the dimples **1334** includes a depth of 0.27 mm. In some
embodiments, each of the dimples **1334** includes a depth of 0.28 mm.

In some embodiments, the liner **1332** includes polytetrafluoroethylene (PTFE). In some
embodiments, the liner **1332** includes PTFE transport and release sheet. In some embodiments,

the PTFE transport and release sheet is Steinbach AG PTFE Type 5307. In some embodiments, the liner **1332** is configured to form within the frontsheet **1316** a plurality of indentations having a size and shape corresponding to those of the plurality of dimples **1334**.

In some embodiments, **FIG. 19C** shows a liner **1336** including a plurality of dimples **1338** formed within a surface thereof. In some embodiments, each of the dimples **1338** includes a length of 1.44 mm to 1.52 mm. In some embodiments, a majority of the dimples **1338** have a length of 1.44 mm to 1.52 mm. In some embodiments, each of the dimples **1338** includes a length of 1.44 mm to 1.51 mm. In some embodiments, each of the dimples **1338** includes a length of 1.44 mm to 1.5 mm. In some embodiments, each of the dimples **1338** includes a length of 1.44 mm to 1.49 mm. In some embodiments, each of the dimples **1338** includes a length of 1.44 mm to 1.48 mm. In some embodiments, each of the dimples **1338** includes a length of 1.44 mm to 1.47 mm. In some embodiments, each of the dimples **1338** includes a length of 1.44 mm to 1.46 mm. In some embodiments, each of the dimples **1338** includes a length of 1.44 mm to 1.45 mm.

In some embodiments, each of the dimples **1338** includes a length of 1.45 mm to 1.52 mm. In some embodiments, each of the dimples **1338** includes a length of 1.45 mm to 1.51 mm. In some embodiments, each of the dimples **1338** includes a length of 1.45 mm to 1.5 mm. In some embodiments, each of the dimples **1338** includes a length of 1.45 mm to 1.49 mm. In some embodiments, each of the dimples **1338** includes a length of 1.45 mm to 1.48 mm. In some embodiments, each of the dimples **1338** includes a length of 1.45 mm to 1.47 mm. In some embodiments, each of the dimples **1338** includes a length of 1.45 mm to 1.46 mm.

In some embodiments, each of the dimples **1338** includes a length of 1.46 mm to 1.52 mm. In some embodiments, each of the dimples **1338** includes a length of 1.46 mm to 1.51 mm. In some embodiments, each of the dimples **1338** includes a length of 1.46 mm to 1.5 mm. In some

embodiments, each of the dimples **1338** includes a length of 1.46 mm to 1.49 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.46 mm to 1.48 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.46 mm to 1.47 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.47 mm to 1.52 mm. In some
5 embodiments, each of the dimples **1338** includes a length of 1.47 mm to 1.51 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.47 mm to 1.5 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.47 mm to 1.49 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.47 mm to 1.48 mm.

In some embodiments, each of the dimples **1338** includes a length of 1.48 mm to 1.52 mm.
10 In some embodiments, each of the dimples **1338** includes a length of 1.48 mm to 1.51 mm. In
some embodiments, each of the dimples **1338** includes a length of 1.48 mm to 1.5 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.48 mm to 1.49 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.49 mm to 1.52 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.49 mm to 1.51 mm. In some
15 embodiments, each of the dimples **1338** includes a length of 1.49 mm to 1.5 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.5 mm to 1.52 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.5 mm to 1.51 mm. In some
embodiments, each of the dimples **1338** includes a length of 1.51 mm to 1.52 mm.

In some embodiments, each of the dimples **1338** includes a length of 1.44 mm. In some
20 embodiments, each of the dimples **1338** includes a length of 1.45 mm. In some embodiments,
each of the dimples **1338** includes a length of 1.46 mm. In some embodiments, each of the dimples
1338 includes a length of 1.47 mm. In some embodiments, each of the dimples **1338** includes a
length of 1.48 mm. In some embodiments, each of the dimples **1338** includes a length of 1.49 mm.

In some embodiments, each of the dimples **1338** includes a length of 1.5 mm. In some embodiments, each of the dimples **1338** includes a length of 1.51 mm. In some embodiments, each of the dimples **1338** includes a length of 1.52 mm.

In some embodiments, each of the dimples **1338** includes a width of 3.19 mm to 3.24 mm.

5 In some embodiments, a majority of the dimples **1338** have a width of 3.19 mm to 3.24 mm. In some embodiments, each of the dimples **1338** includes a width of 3.19 mm to 3.23 mm. In some embodiments, each of the dimples **1338** includes a width of 3.19 mm to 3.22 mm. In some embodiments, each of the dimples **1338** includes a width of 3.19 mm to 3.21 mm. In some embodiments, each of the dimples **1338** includes a width of 3.19 mm to 3.20 mm. In some
10 embodiments, each of the dimples **1338** includes a width of 3.2 mm to 3.24 mm. In some embodiments, each of the dimples **1338** includes a width of 3.2 mm to 3.23 mm. In some embodiments, each of the dimples **1338** includes a width of 3.2 mm to 3.22 mm. In some embodiments, each of the dimples **1338** includes a width of 3.2 mm to 3.21 mm. In some embodiments, each of the dimples **1338** includes a width of 3.21 mm to 3.24 mm. In some
15 embodiments, each of the dimples **1338** includes a width of 3.21 mm to 3.23 mm. In some embodiments, each of the dimples **1338** includes a width of 3.21 mm to 3.22 mm. In some embodiments, each of the dimples **1338** includes a width of 3.22 mm to 3.24 mm. In some embodiments, each of the dimples **1338** includes a width of 3.22 mm to 3.23 mm. In some embodiments, each of the dimples **1338** includes a width of 3.23 mm to 3.24 mm.

20 In some embodiments, each of the dimples **1338** includes a width of 3.19 mm. In some embodiments, each of the dimples **1338** includes a width of 3.2 mm. In some embodiments, each of the dimples **1338** includes a width of 3.21 mm. In some embodiments, each of the dimples

1338 includes a width of 3.22 mm. In some embodiments, each of the dimples **1338** includes a width of 3.23 mm. In some embodiments, each of the dimples **1338** includes a width of 3.24 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.32 mm. In some embodiments, a majority of the dimples **1338** have a depth of 0.19 mm to 0.32 mm. In
5 some embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.31 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.3 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.29 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.28 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.27 mm. In some
10 embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.26 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.25 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.24 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.23 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.22 mm. In some
15 embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.21 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.19 mm to 0.2 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.32 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.31 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.3 mm. In some
20 embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.29 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.28 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.27 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.26 mm. In some

embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.25 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.24 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.23 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.22 mm. In some
5 embodiments, each of the dimples **1338** includes a depth of 0.2 mm to 0.21 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.32 mm.
In some embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.31 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.3 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.29 mm. In some
10 embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.28 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.27 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.26 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.25 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.24 mm. In some
15 embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.23 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.21 mm to 0.22 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.22 mm to 0.32 mm.
In some embodiments, each of the dimples **1338** includes a depth of 0.22 mm to 0.31 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.22 mm to 0.3 mm. In some
20 embodiments, each of the dimples **1338** includes a depth of 0.22 mm to 0.29 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.22 mm to 0.28 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.22 mm to 0.27 mm. In some
embodiments, each of the dimples **1338** includes a depth of 0.22 mm to 0.26 mm. In some

embodiments, each of the dimples **1338** includes a depth of 0.22 mm to 0.25 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.22 mm to 0.24 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.22 mm to 0.23 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.23 mm to 0.32 mm.

5 In some embodiments, each of the dimples **1338** includes a depth of 0.23 mm to 0.31 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.23 mm to 0.3 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.23 mm to 0.29 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.23 mm to 0.28 mm. In some
10 embodiments, each of the dimples **1338** includes a depth of 0.23 mm to 0.27 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.23 mm to 0.26 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.23 mm to 0.25 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.23 mm to 0.24 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.24 mm to 0.32 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.24 mm to 0.31 mm. In some
15 embodiments, each of the dimples **1338** includes a depth of 0.24 mm to 0.3 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.24 mm to 0.29 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.24 mm to 0.28 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.24 mm to 0.27 mm. In some
20 embodiments, each of the dimples **1338** includes a depth of 0.24 mm to 0.26 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.24 mm to 0.25 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.25 mm to 0.32 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.25 mm to 0.31 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.25 mm to 0.3 mm. In some

embodiments, each of the dimples **1338** includes a depth of 0.25 mm to 0.29 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.25 mm to 0.28 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.25 mm to 0.27 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.25 mm to 0.26 mm.

5 In some embodiments, each of the dimples **1338** includes a depth of 0.26 mm to 0.32 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.26 mm to 0.31 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.26 mm to 0.3 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.26 mm to 0.29 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.26 mm to 0.28 mm. In some
10 embodiments, each of the dimples **1338** includes a depth of 0.26 mm to 0.27 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.27 mm to 0.32 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.27 mm to 0.31 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.27 mm to 0.3 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.27 mm to 0.29 mm. In some
15 embodiments, each of the dimples **1338** includes a depth of 0.27 mm to 0.28 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.28 mm to 0.32 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.28 mm to 0.31 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.28 mm to 0.3 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.28 mm to 0.29 mm.

20 In some embodiments, each of the dimples **1338** includes a depth of 0.29 mm to 0.32 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.29 mm to 0.31 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.29 mm to 0.3 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.3 mm to 0.32 mm. In some

embodiments, each of the dimples **1338** includes a depth of 0.3 mm to 0.31 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.31 mm to 0.32 mm.

In some embodiments, each of the dimples **1338** includes a depth of 0.19 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.2 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.21 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.22 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.23 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.24 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.25 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.252 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.26 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.27 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.28 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.29 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.3 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.31 mm. In some embodiments, each of the dimples **1338** includes a depth of 0.32 mm.

In some embodiments, the liner **1336** includes a polymer coated fiber reinforced membrane. In some embodiments, the liner **1336** is a polytetrafluoroethylene (PTFE) coated fiber reinforced membrane. In some embodiments, the liner **1336** is Xiya A membrane. In some embodiments, the liner **1336** is configured to form within the frontsheet **1316** a plurality of indentations having a size and shape corresponding to those of the plurality of dimples **1338**.

In another embodiment, the indentations are created by embossing a portion of the frontsheet **1316**. In another embodiment, the indentations are created by embossing the polymer layer **1320** of the frontsheet **1316**.

Still referring to **FIGS. 19A** through **19C**, in some embodiments, each of the dimples **1330** is oblong in shape. In some embodiments, a majority of the dimples **1330** is oblong in shape. In some embodiments, the dimples **1330** form a grain pattern. In some embodiments, the grain pattern extends in a direction **Y**. In some embodiments, each of the dimples **1334** is oblong in shape. In some embodiments, a majority of the dimples **1334** is oblong in shape. In some embodiments, the dimples **1334** form a grain pattern. In some embodiments, the grain pattern extends in a direction **Y**. In some embodiments, each of the dimples **1338** is oblong in shape. In some embodiments, a majority of the dimples **1338** is oblong in shape. In some embodiments, the dimples **1338** form a grain pattern. In some embodiments, the grain pattern extends in a direction **Y**.

Referring to **FIG. 20**, the at least one solar cell **12** includes a plurality of cell fingers **1340**. In some embodiments, the plurality of cell fingers **1340** form a grain pattern. In some embodiments, the grain pattern of the plurality of cell fingers **1340** extends in a direction **Y**. In some embodiments, the cell fingers **1340** include a pitch **P** (the distance from a center, longitudinal axis of one of the cell fingers **1340** to a center, longitudinal axis of another adjacent one of the cell fingers **1340**).

In some embodiments, the cell fingers **1340** include a pitch of 1.0 mm to 1.5 mm. In another embodiment, the cell fingers **1340** include a pitch of 1.0 mm to 1.4 mm. In another embodiment, the cell fingers **1340** include a pitch of 1.0 mm to 1.3 mm. In another embodiment, the cell fingers **1340** include a pitch of 1.0 mm to 1.2 mm. In another embodiment, the cell fingers **1340** include a pitch of 1.0 mm to 1.1 mm. In some embodiments, the cell fingers **1340** include a pitch of 1.1 mm to 1.5 mm. In another embodiment, the cell fingers **1340** include a pitch of 1.1 mm to 1.4 mm. In another embodiment, the cell fingers **1340** include a pitch of 1.1 mm to 1.3

mm. In another embodiment, the cell fingers **1340** include a pitch of 1.1 mm to 1.2 mm. In some embodiments, the cell fingers **1340** include a pitch of 1.2 mm to 1.5 mm. In another embodiment, the cell fingers **1340** include a pitch of 1.2 mm to 1.4 mm. In another embodiment, the cell fingers **1340** include a pitch of 1.2 mm to 1.3 mm. In some embodiments, the cell fingers **1340** include a pitch of 1.3 mm to 1.5 mm. In another embodiment, the cell fingers **1340** include a pitch of 1.3 mm to 1.4 mm. In some embodiments, the cell fingers **1340** include a pitch of 1.4 mm to 1.5 mm.

In some embodiments, the photovoltaic module **1310** is configured to be installed on a roof deck. In some embodiments, a system includes a plurality of the photovoltaic module **1310**. In some embodiments, when the photovoltaic module **1310** is installed on a roof deck of a structure, the photovoltaic module **1310** module is viewable from the vantage point located at a ground level of the structure.

FIGS. 21A through **21C** show embodiments of the photovoltaic module **1310** including the liner **1328**. Referring to **FIG. 21A**, in some embodiments, the grain pattern of the liner **1328** is positioned parallel to (zero (0) degrees relative to) the grain pattern of the cell fingers **1340** of the at least one solar cell **1312** when the liner **1328** overlays the polymer layer **1320** to form a plurality of indentations within the frontsheet **1316**. In some embodiments, an interference fringe pattern between the plurality of indentations and cell fingers **1340** is viewable.

Referring to **FIG. 21B**, in some embodiments, the grain pattern of the liner **1328** is positioned perpendicular to (90 degrees relative to) the grain pattern of the cell fingers **1340** of the at least one solar cell **1312** when the liner **1328** overlays the polymer layer **1320** to form a plurality of indentations within the frontsheet **1316**. In some embodiments, an interference fringe pattern between the plurality of indentations and the cell fingers **1340** is viewable.

Referring to **FIG. 21C**, in some embodiments, the grain pattern of the liner **1328** is positioned 45 degrees relative to the grain pattern of the cell fingers **1340** of the at least one solar cell **1312** when the liner **1328** overlays the polymer layer **1320** to form a plurality of indentations within the frontsheet **1316**. In some embodiments, an interference fringe pattern between the plurality of indentations and cell fingers **1340** is faint and slightly viewable.

FIGS. 22A through **22C** show embodiments of the photovoltaic module **1310** including the liner **1332**. Referring to **FIG. 22A**, in some embodiments, the grain pattern of the liner **1332** is positioned parallel to (zero (0) degrees relative to) the grain pattern of the cell fingers **1340** of the at least one solar cell **1312** when the liner **1332** overlays the polymer layer **1320** to form a plurality of indentations within the frontsheet **1316**. In some embodiments, there is no viewable interference fringe pattern between the plurality of indentations and the cell fingers **1340**.

Referring to **FIG. 22B**, in some embodiments, the grain pattern of the liner **1332** is positioned perpendicular to (90 degrees relative to) the grain pattern of the cell fingers **1340** of the at least one solar cell **1312** when the liner **1332** overlays the polymer layer **1320** to form a plurality of indentations within the frontsheet **1316**. In some embodiments, there is no viewable interference fringe pattern between the plurality of indentations and the cell fingers **1340**.

Referring to **FIG. 22C**, in some embodiments, the grain pattern of the liner **1332** is positioned 45 degrees relative to the grain pattern of the cell fingers **1340** of the at least one solar cell **1312** when the liner **1332** overlays the polymer layer **1320** to form a plurality of indentations within the frontsheet **1316**. In some embodiments, there is no viewable interference fringe pattern between the plurality of indentations and the cell fingers **1340**.

FIGS. 23A through **23C** show embodiments of the photovoltaic module **1310** including the liner **1336**. Referring to **FIG. 23A**, in some embodiments, the grain pattern of the liner **1336**

is positioned parallel to (zero (0) degrees relative to) the grain pattern of the cell fingers **1340** of the at least one solar cell **1312** when the liner **1336** overlays the polymer layer **1320** to form a plurality of indentations within the frontsheet **1316**. In some embodiments, an interference fringe pattern between the plurality of indentations and the cell fingers **1340** is viewable.

5 Referring to **FIG. 23B**, in some embodiments, the grain pattern of the liner **1336** is positioned perpendicular to (90 degrees relative to) the grain pattern of the cell fingers **1340** of the at least one solar cell **1312** when the liner **1336** overlays the polymer layer **1320** to form the plurality of indentations within the frontsheet **1316**. In some embodiments, there is no viewable interference fringe pattern between the plurality of indentations and the cell fingers **1340**.

10 Referring to **FIG. 23C**, in some embodiments, the grain pattern of the liner **1336** is positioned 45 degrees relative to the grain pattern of the cell fingers **1340** of the at least one solar cell **1312** when the liner **1336** overlays the polymer layer **1320** to form the plurality of indentations within the frontsheet **1316**. In some embodiments, there is no viewable interference fringe pattern between the plurality of indentations and the cell fingers **1340**.

15 In some embodiments, the liner **1326** is configured to form a plurality of indentations within the any of the frontsheets **116, 216, 316, 416, 516, 616, 716, 916, 1016, 1116** of the roofing modules **110, 210, 310, 410, 510, 610, 710, 1010** and the photovoltaic module **1110**, respectively. In some embodiments, the liner **1326** is configured to form the plurality of indentations within any of the frontsheets **116, 216, 316, 416, 516, 616, 716, 916, 1016, 1116** of the roofing modules **110,**
20 **210, 310, 410, 510, 610, 710, 1010** and the photovoltaic module **1110**, respectively. In some embodiments, the liner **1326** is removed after formation of the plurality of indentations. In some embodiments, the liner **1326** includes a structure similar to the liner **1328** including the dimples **1330**. In another embodiment, the liner **1326** includes a structure similar to the liner **1332**

including the dimples **1334**. In another embodiment, the liner **1326** includes a structure similar to the liner **1336** including the dimples **1338**. In certain embodiments, the liners **1328**, **1332**, **1336** may be arranged and positioned relative to the depiction of the cell fingers similar to any of those described above and shown in **FIGS. 21A** through **23C**.

5 In certain embodiments, the liner **1326** is configured to form the indentations **804** of the roofing module **810**. In some embodiments, the liner **1326** includes a structure similar to the liner **1328** including the dimples **1330**. In another embodiment, the liner **1326** includes a structure similar to the liner **1332** including the dimples **1334**. In another embodiment, the liner **1326** includes a structure similar to the liner **1336** including the dimples **1338**.

10 Referring to **FIG. 24**, in some embodiments, a liner **1410** includes a first surface **1412**. In some embodiments, the first surface **1412** is smooth. In some embodiments, the first surface **1412** has no texture. In some embodiments, the liner **1410** is configured to form a smooth outer surface on any of the frontsheets **116**, **216**, **316**, **416**, **516**, **616**, **716**, **916**, **1016**, **1116** of the roofing modules **110**, **210**, **310**, **410**, **510**, **610**, **710**, **1010** and the photovoltaic module **1110**, respectively.

15 Referring to **FIG. 25**, in some embodiments, a scrim **1510** includes a mesh **1512** having a plurality of openings **1514**. In some embodiments, each of the openings **1514** is 5 mm x 5 mm. In some embodiments, each of the openings **1514** is 4 mm x 4 mm. In some embodiments, each of the openings **1514** is 3 mm x 3 mm. In some embodiments, each of the openings **1514** is 2 mm x 2 mm. In some embodiments, each of the openings **1514** is 1 mm x 1 mm. In some
20 embodiments, the mesh **1512** has a thickness of 1 mm. In some embodiments, the mesh **1512** has a thickness of 2 mm. In some embodiments, the mesh **1512** has a thickness of 0.5 mm. In some embodiments, the scrim **1510** is composed of fiberglass. In some embodiments, the scrim **1510** is composed of metal. In some embodiments, the scrim **1510** is composed of plastic. In some

embodiments, the scrim **1510** is configured to form a plurality of indentations within the any of the frontsheets **116, 216, 316, 416, 516, 616, 716, 916, 1016, 1116** of the roofing modules **110, 210, 310, 410, 510, 610, 710, 1010** and the photovoltaic module **1110**, respectively.

FIG. 26 is graph of gloss versus texture of textured roofing shingles formed by the liner **1410** (labeled as “smooth”), the liner **1332** (labeled as “medium”), and the liner **1336** (labeled as “rough”). In some embodiments, each of the roofing shingles is composed of thermoplastic polyolefin (TPO). In some embodiments, each of the roofing shingles is composed of carbon black TPO. Table I below sets forth embodiments of the textures formed by the liners **1410, 1332, and 1336**, the viewing angles, and the measured gloss. In some embodiments, the angle of 85 degrees is approximately a viewing angle of from an observer on a street level of a structure comprising a roof deck that includes the textures roofing modules:

TABLE I

Texture	Angle	Gloss
Smooth	20°	2.9
Smooth	20°	2.8
Smooth	20°	0.7
Smooth	60°	15.3
Smooth	60°	16.7
Smooth	60°	10.4
Smooth	85°	27.0
Smooth	85°	25.5
Smooth	85°	25.2

Medium	20°	0.2
Medium	20°	0.2
Medium	20°	0.2
Medium	60°	1.3
Medium	60°	1.0
Medium	60°	1.1
Medium	85°	0.1
Medium	85°	0.1
Medium	85°	0.1
Rough	20°	0.2
Rough	20°	0.2
Rough	20°	0.1
Rough	60°	1.2
Rough	60°	1.3
Rough	60°	1.0
Rough	85°	1.1
Rough	85°	0.9
Rough	85°	0.9

FIG. 27 illustrates some embodiments of a roofing system **1600** including a plurality of roofing shingles **1610**. In some embodiments, some of the roofing shingles **1610** are textured by the liner **1410**. In some embodiments, some of the roofing shingles **1610** are textured by the liner **1332**. In some embodiments, some of the roofing shingles **1610** are textured by the liner **1336**. In

some embodiments, the different textures diffract various light wavelengths in different directions. In some embodiment, the different textures result in different colors. In some embodiments, the different textures result in different colors at eye level. In some embodiments, the colors will change throughout a day depending upon the sun's ray incident position relative the roofing system.

5

CLAIMS

What is claimed is:

1. A system, comprising:

5 a plurality of roofing modules, each of the roofing modules includes

a first layer

wherein the first layer includes

a first surface, and

a second surface opposite the first surface,

10 wherein the first surface is textured, and

a second layer,

wherein the second layer is juxtaposed with the second surface of

the first layer,

wherein each of the roofing modules does not include a solar cell;

15 and

a plurality of photovoltaic modules, each of the plurality of photovoltaic modules includes

at least one solar cell,

an encapsulant encapsulating the at least one solar cell, wherein the

20 encapsulant of the photovoltaic module includes a first surface and a second surface

opposite the first surface of the encapsulant of the photovoltaic module,

a frontsheet,

wherein the frontsheet includes

a first surface, and
a second surface opposite the first surface of the frontsheet,
wherein the second surface of the frontsheet is juxtaposed
with the first surface of the encapsulant,

5 wherein the first surface of the frontsheet is textured, and
a backsheet juxtaposed with the second surface of the encapsulant of the
photovoltaic module,

wherein the photovoltaic modules are configured to be installed on a roof deck of
a structure,

10 wherein the roofing modules are configured to be installed on the roof deck
proximate to the photovoltaic modules, and

wherein an appearance of the roofing modules aesthetically matches an appearance
of the photovoltaic modules when viewed from a vantage point located at a ground level
of the structure.

15

2. The system of Claim 1, wherein the first layer is composed of a polymer.

3. The system of Claim 2, wherein the first layer is composed of thermoplastic polyolefin
(TPO).

20

4. The system of Claim 1, wherein the second layer is composed of a polymer.

5. The system of Claim 4, wherein the second layer is composed of thermoplastic polyolefin
(TPO).

6. The system of Claim 4, wherein the second layer includes fiberglass.

7. The system of Claim 1, wherein the first layer has a thickness of 25 mils to 100 mils.

5

8. The system of Claim 4, wherein the second layer has a thickness of 25 mils to 200 mils.

9. The system of Claim 1, wherein the first layer includes a pattern printed on the first surface of the first layer.

10

10. The system of Claim 9, wherein the pattern is a depiction of solar cells.

11. The system of Claim 1, wherein the first layer is colored.

15

12. The system of Claim 11, wherein the first layer is black colored.

13. The system of Claim 1, wherein the second layer is colored.

14. The system of Claim 13, wherein the second layer is black colored.

20

15. A method, comprising the steps of:

obtaining a plurality of roofing modules, each of the roofing modules includes

a first layer

wherein the first layer includes

25

a first surface, and

a second surface opposite the first surface,

wherein the first surface is textured, and

a second layer,

wherein the second layer is juxtaposed with the second surface of the first layer,

5 wherein each of the roofing modules does not include a solar cell;

obtaining a plurality of photovoltaic modules, each of the plurality of photovoltaic modules includes

at least one solar cell,

an encapsulant encapsulating the at least one solar cell, wherein the encapsulant of
10 the photovoltaic module includes a first surface and a second surface opposite the first surface of the encapsulant of the photovoltaic module,

a frontsheet,

wherein the frontsheet includes

a first surface, and

15 a second surface opposite the first surface of the frontsheet,

wherein the second surface of the frontsheet is juxtaposed with the first surface of the encapsulant,

wherein the first surface of the frontsheet is textured, and

a backsheet juxtaposed with the second surface of the encapsulant of the
20 photovoltaic module;

installing the plurality of photovoltaic modules on a roof deck of a structure;

cutting at least one of the plurality of roofing modules to a size and shape; and

installing the plurality of roofing modules on the roof deck proximate to the plurality of photovoltaic modules,

wherein the at least one solar cell of at least one of the plurality of photovoltaic modules is electrically active, and

5 wherein an appearance of the roofing modules aesthetically matches an appearance of the photovoltaic modules when viewed from a vantage point located at a ground level of the structure.

16. The method of Claim 15, wherein each of the first layer and the second layer is composed of a polymer.

10 17. The method of Claim 16, wherein each of the first layer and the second layer is composed of thermoplastic polyolefin (TPO).

18. The method of Claim 16, wherein the first layer has a thickness of 25 mils to 100 mils, and
15 wherein the second layer has a thickness of 25 mils to 200 mils.

19. The method of Claim 16, wherein the first layer includes a pattern printed on the first surface of the first layer.

20 20. The method of Claim 19, wherein the pattern is a depiction of solar cells.

1/20

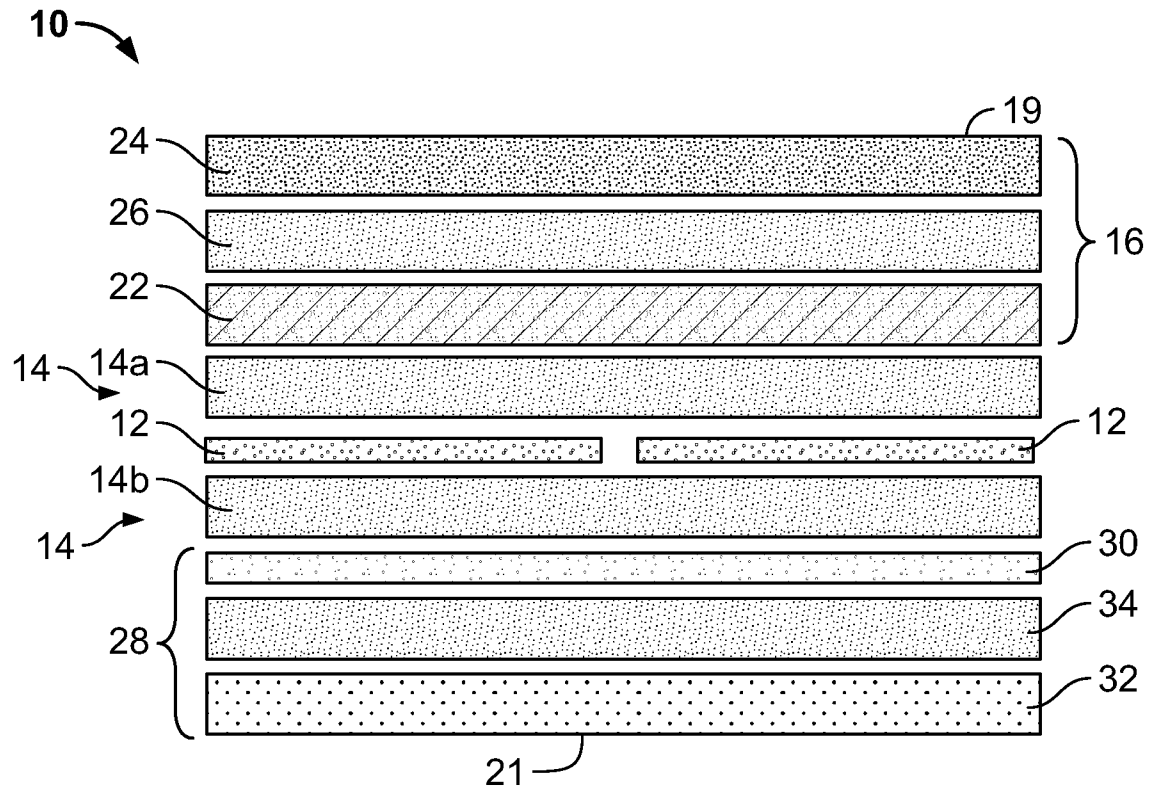


FIG. 1

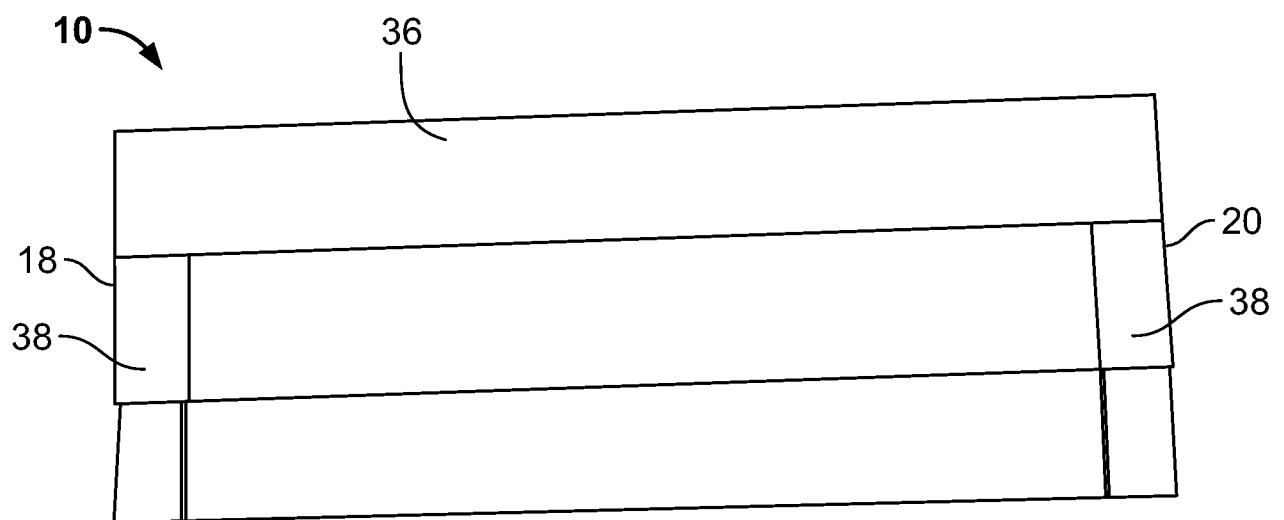


FIG. 2

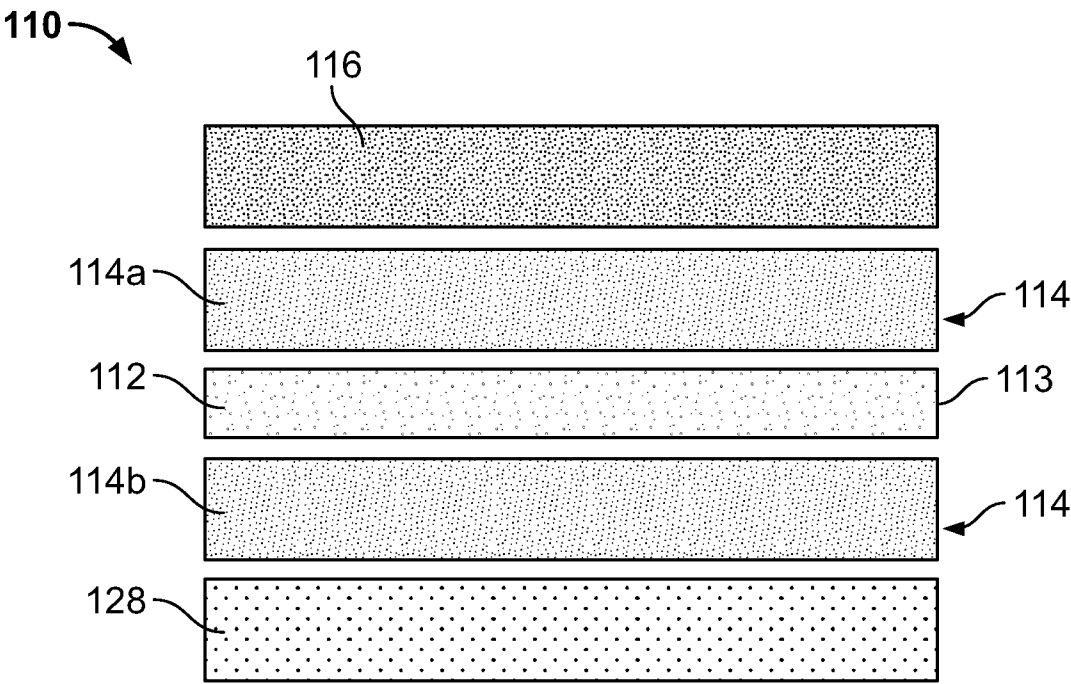


FIG. 3

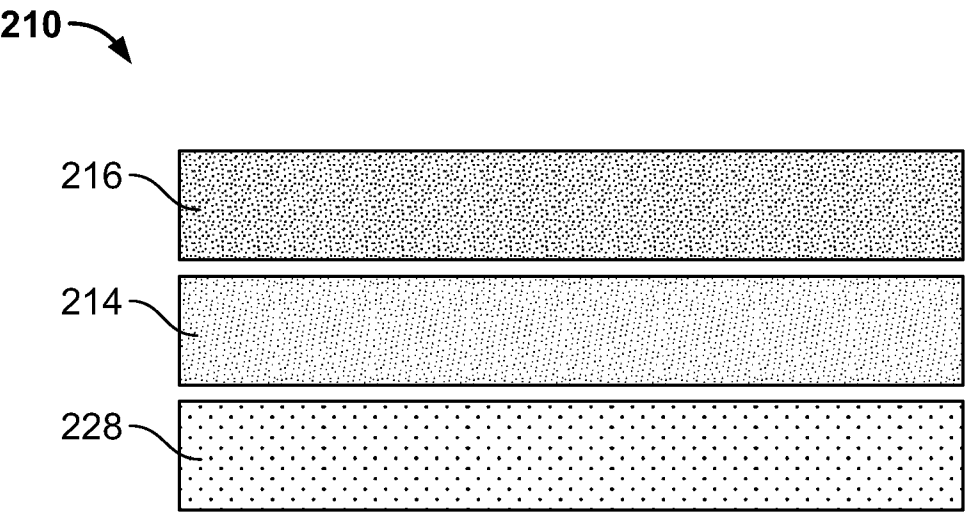


FIG. 4

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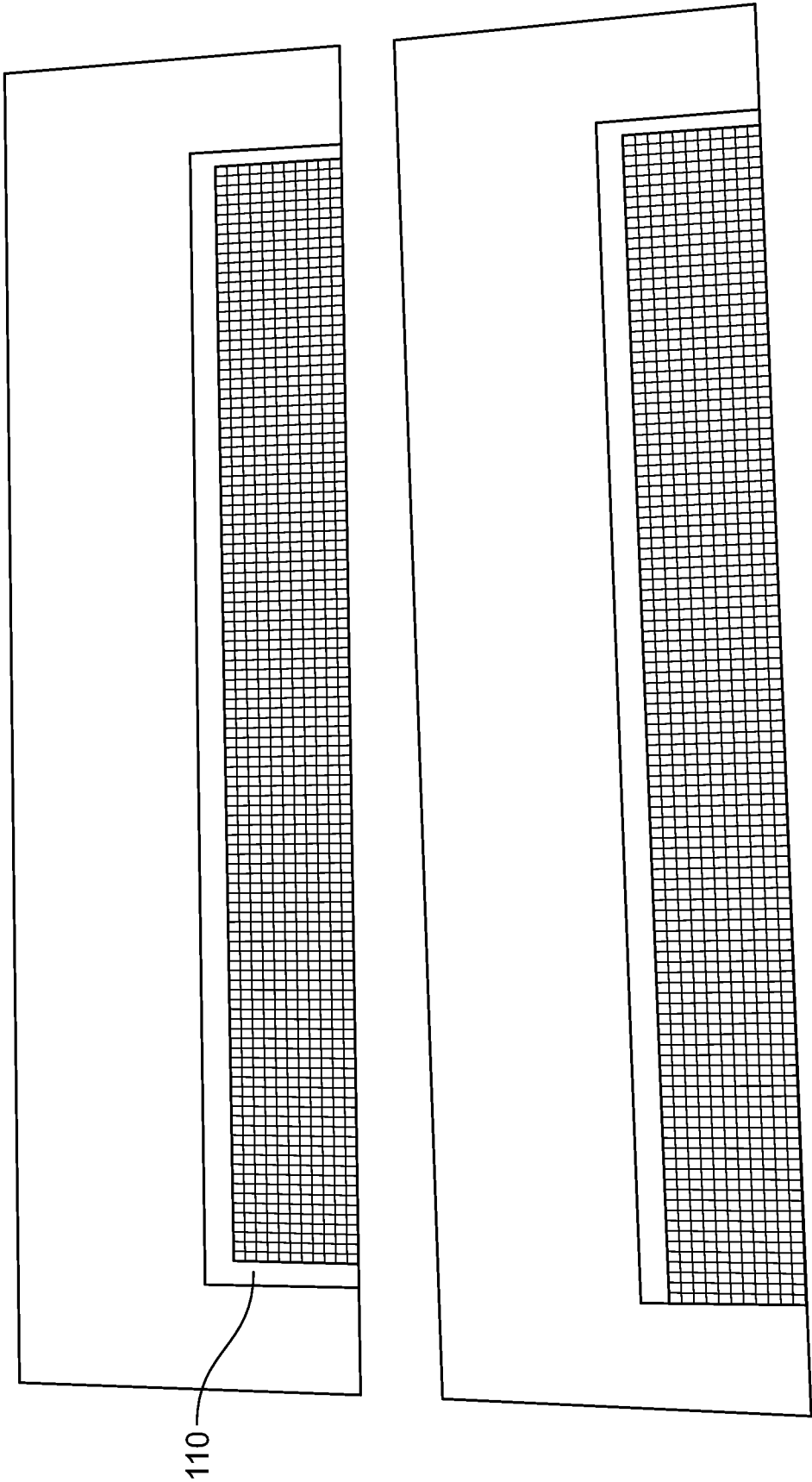


FIG. 5

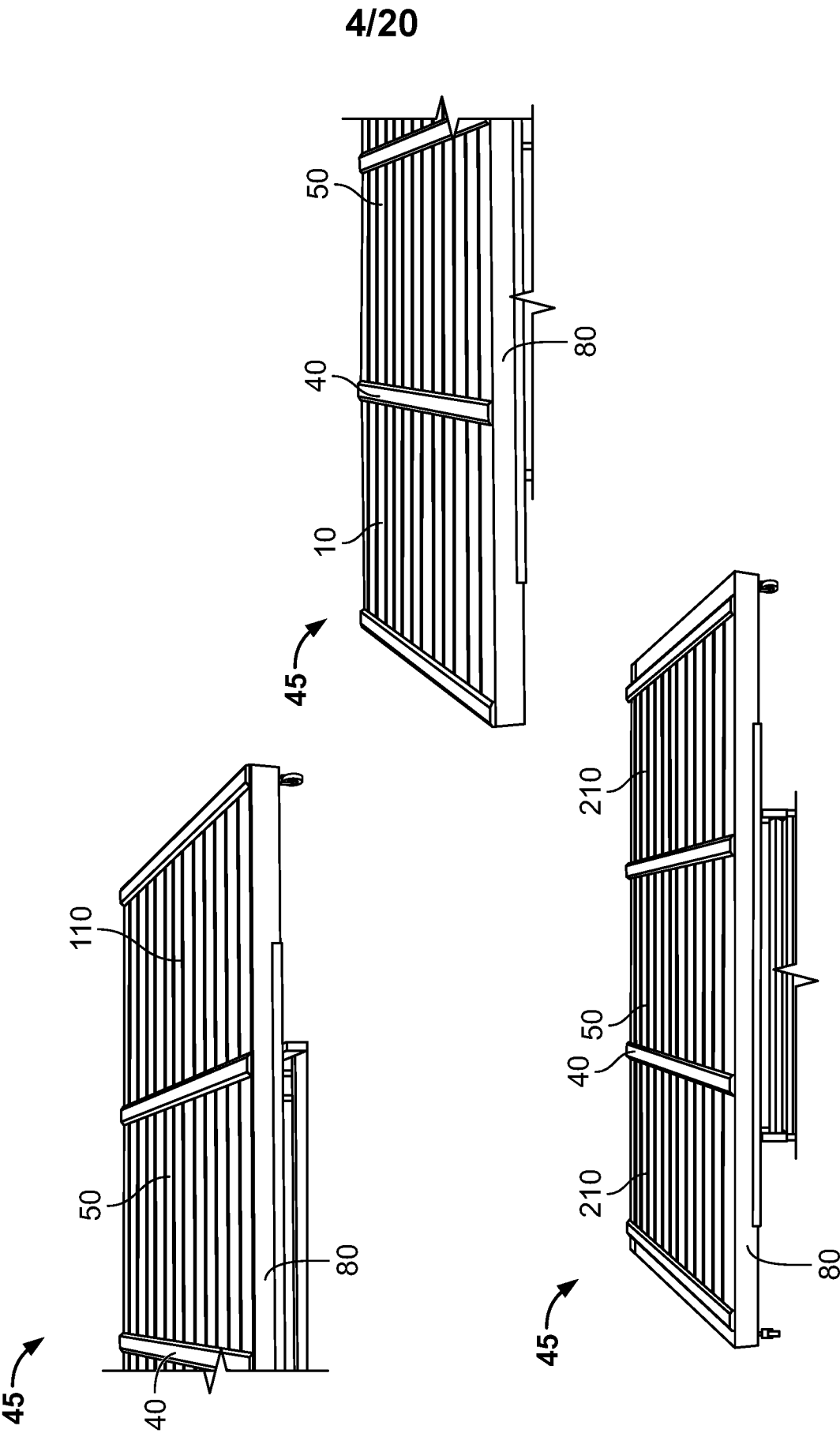


FIG. 6

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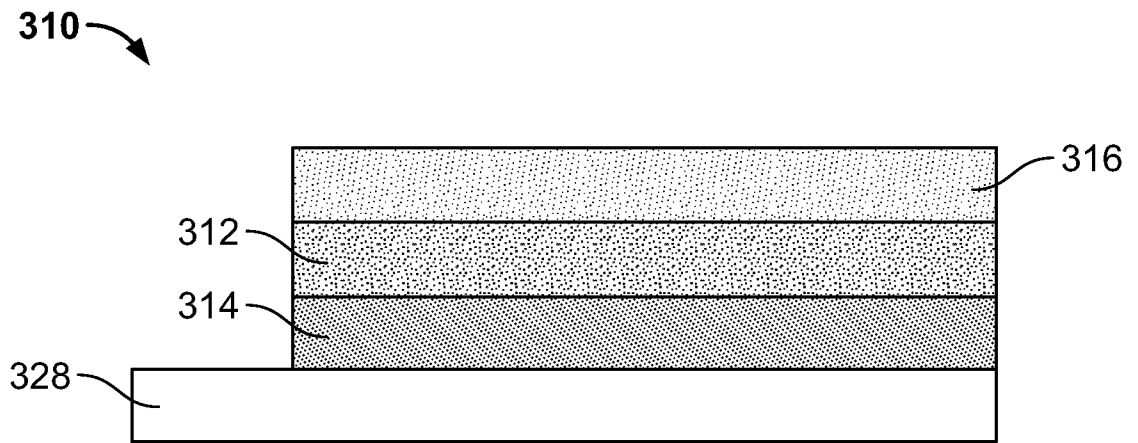


FIG. 7



FIG. 8

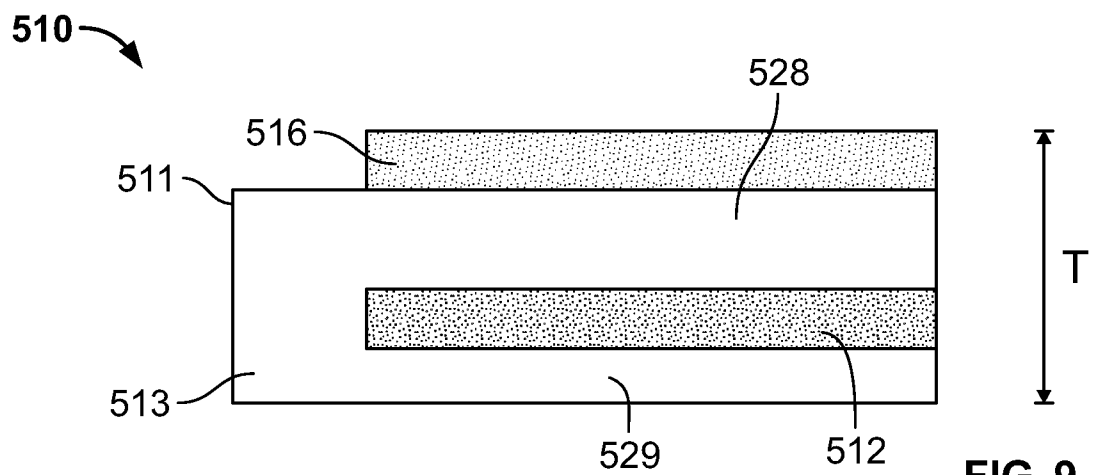


FIG. 9

6/20

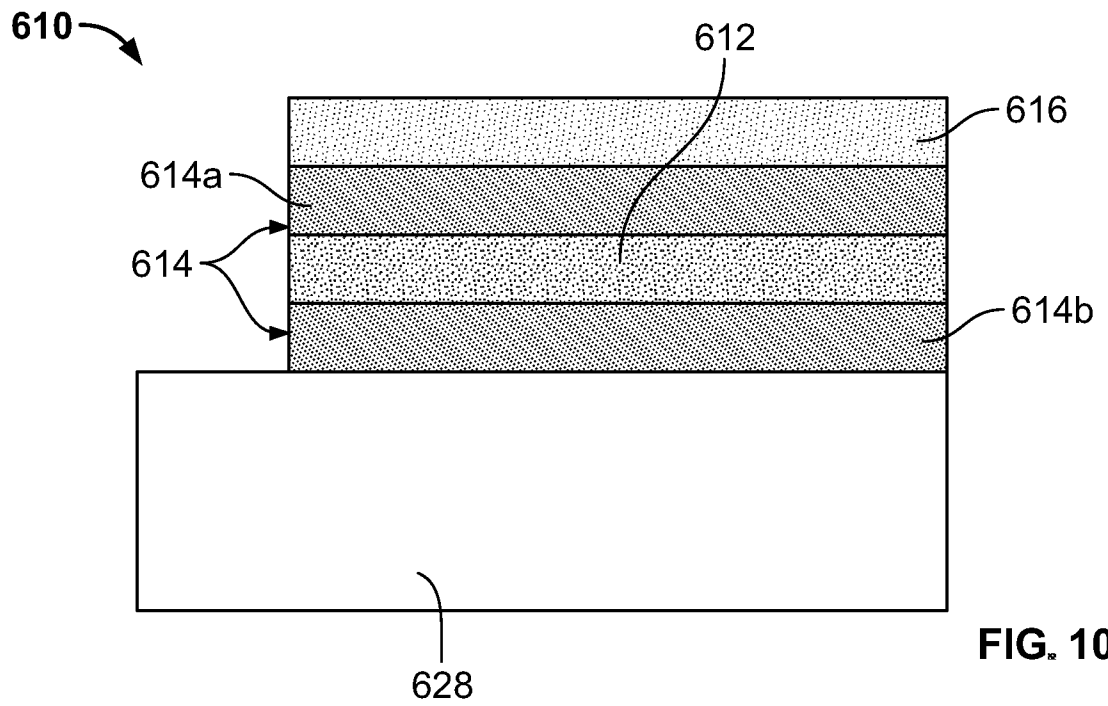


FIG. 10

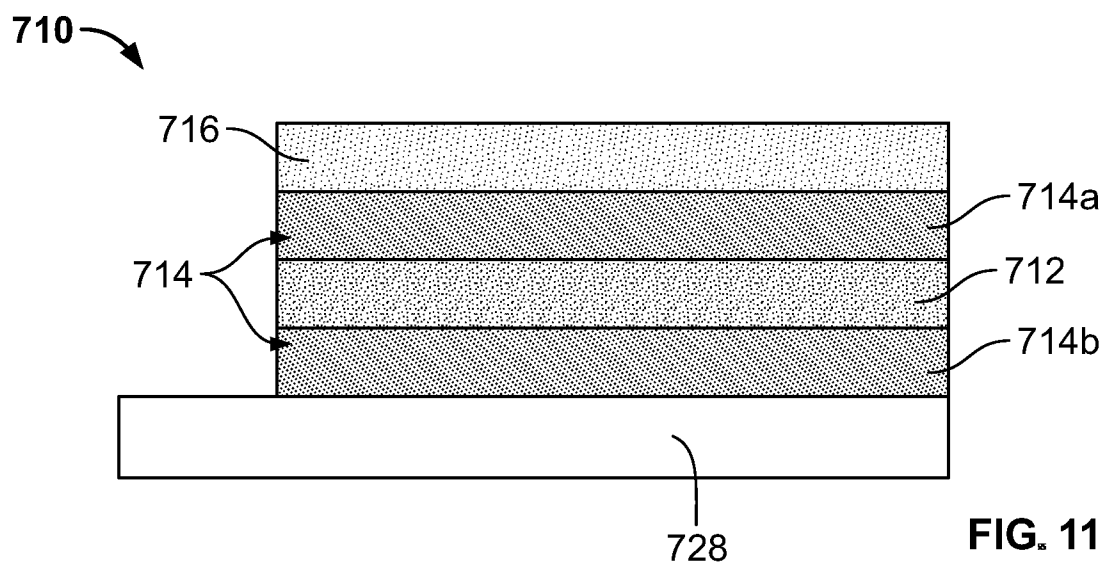


FIG. 11

7/20

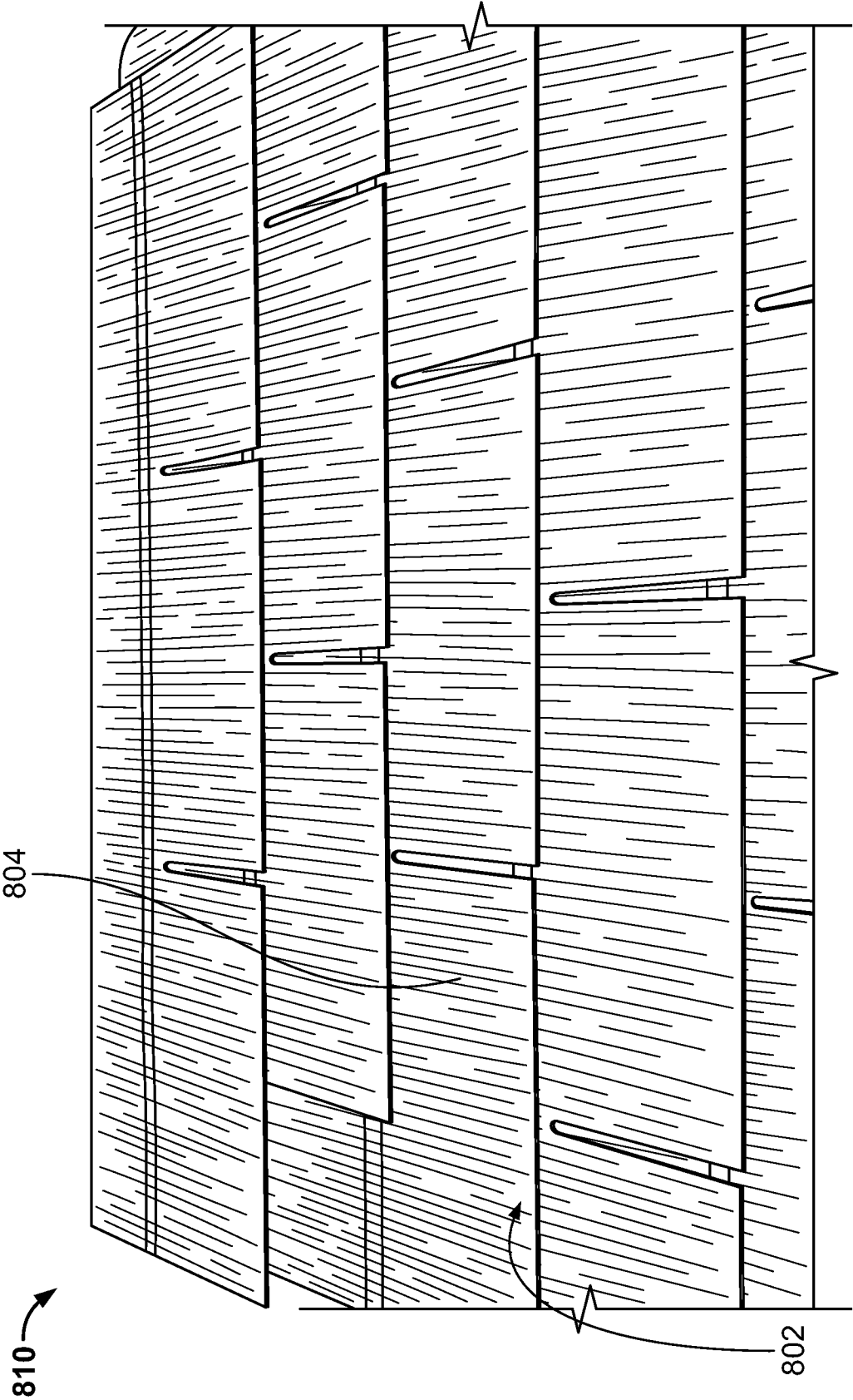


FIG. 12A

8/20

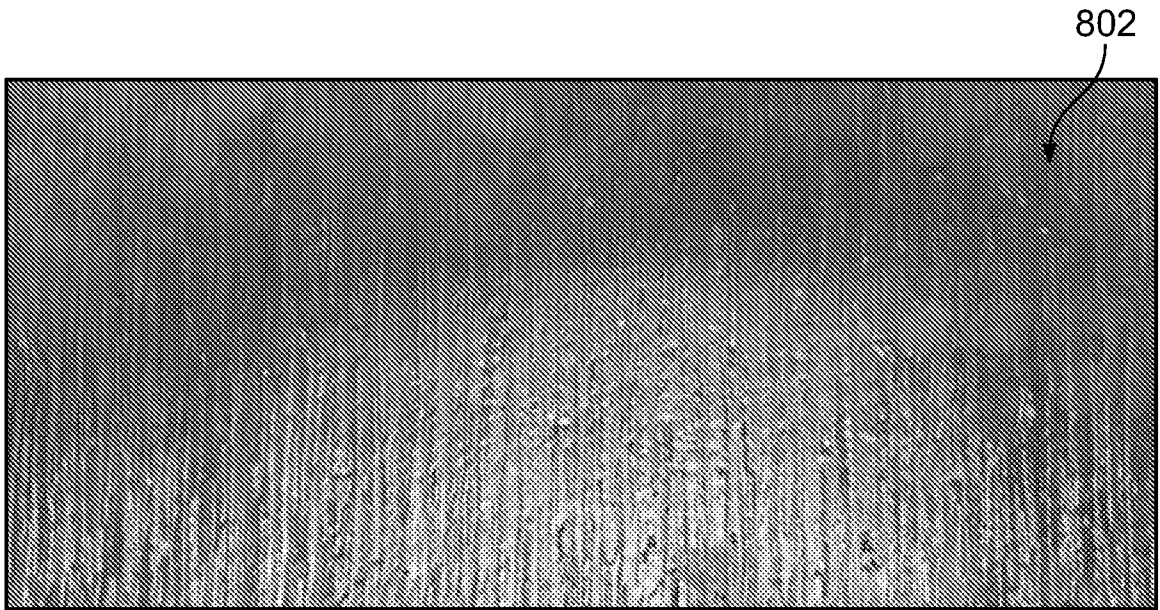


FIG. 12B



FIG. 12C

9/20

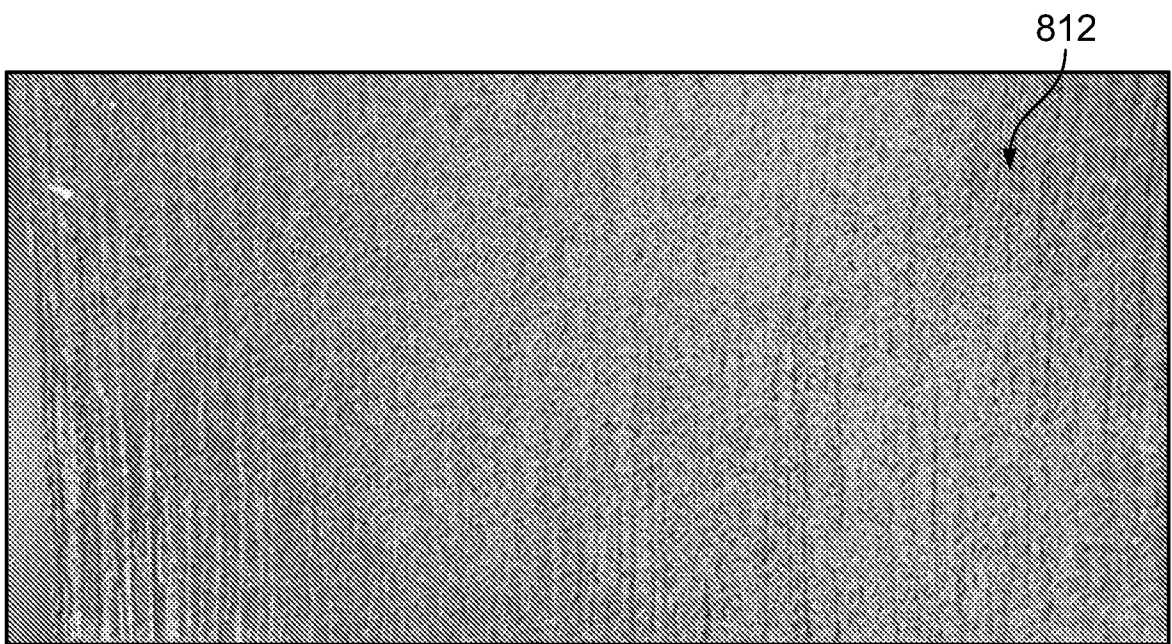


FIG. 12D

10/20

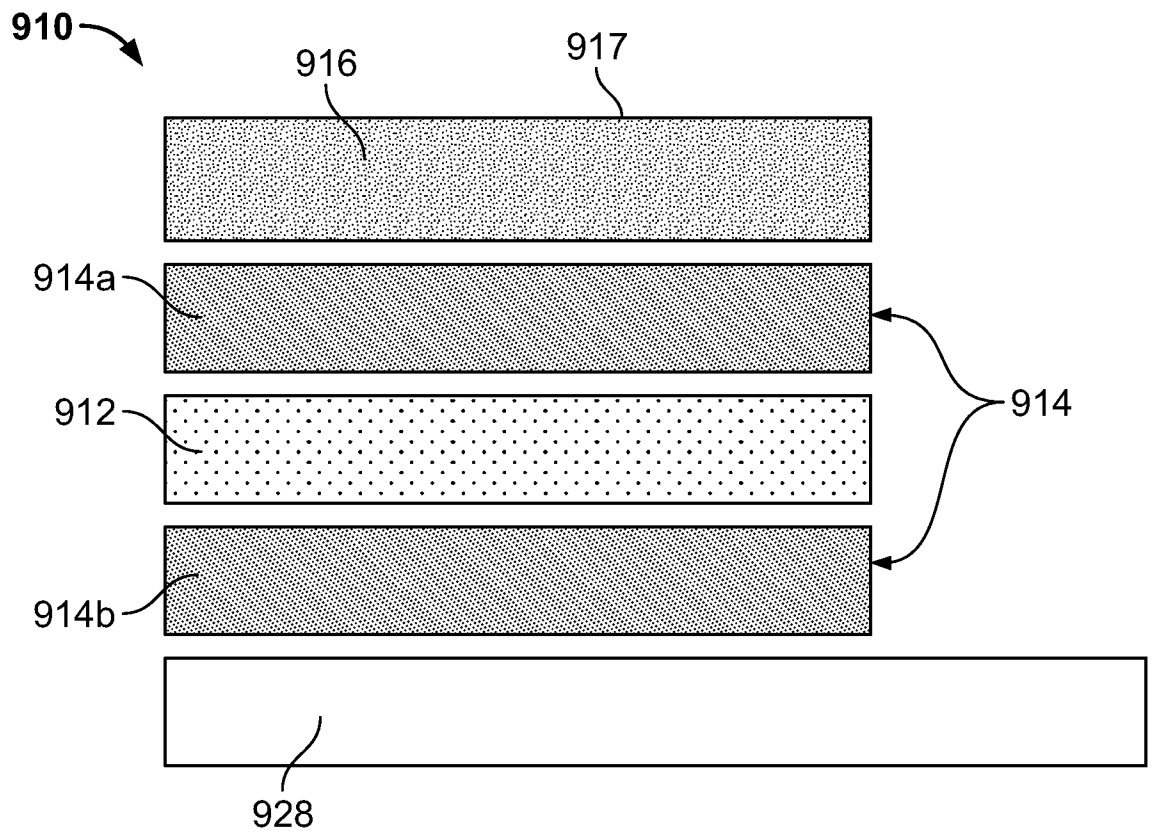


FIG. 13

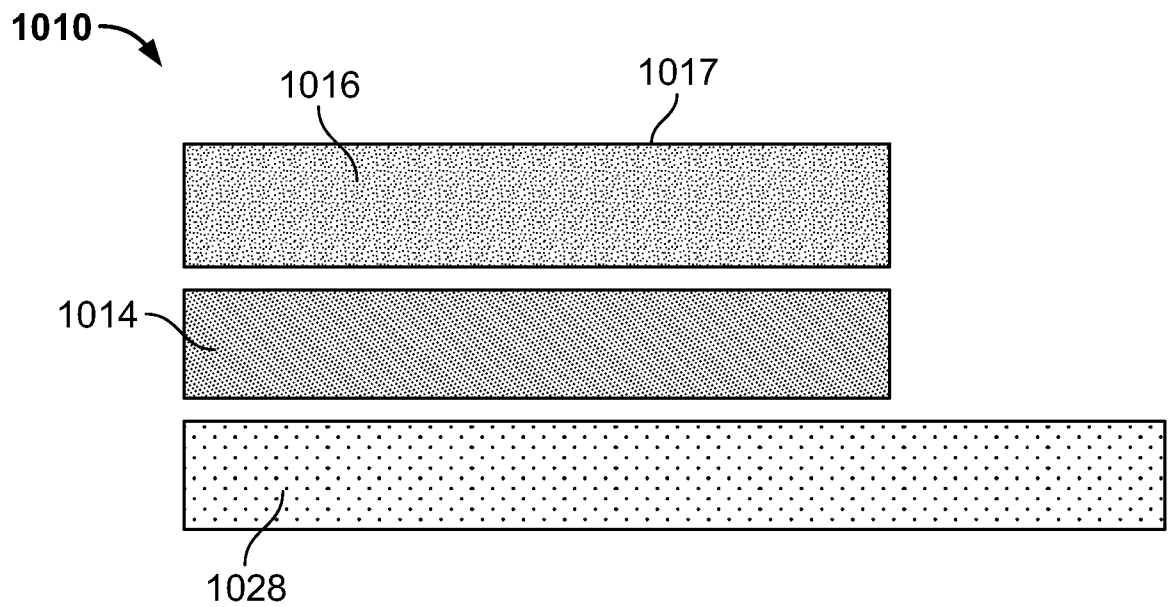


FIG. 14

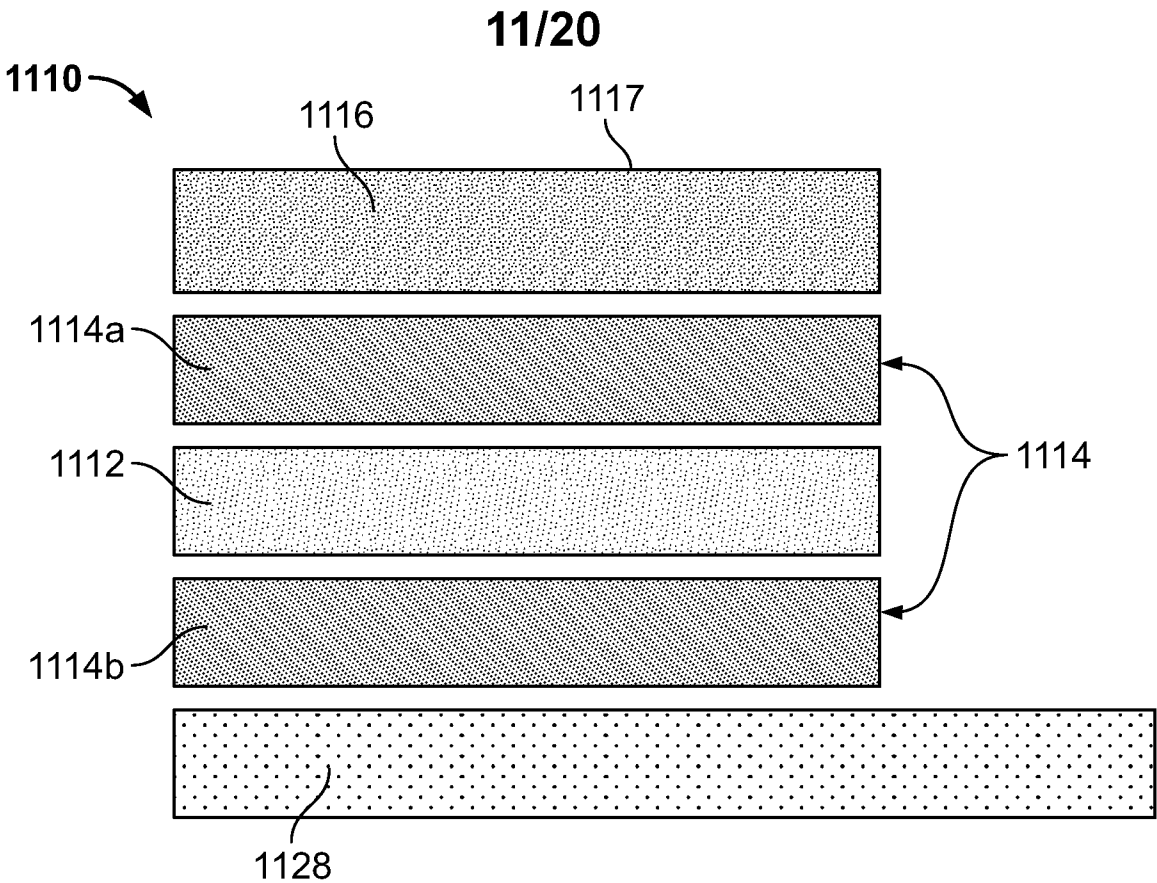


FIG. 15

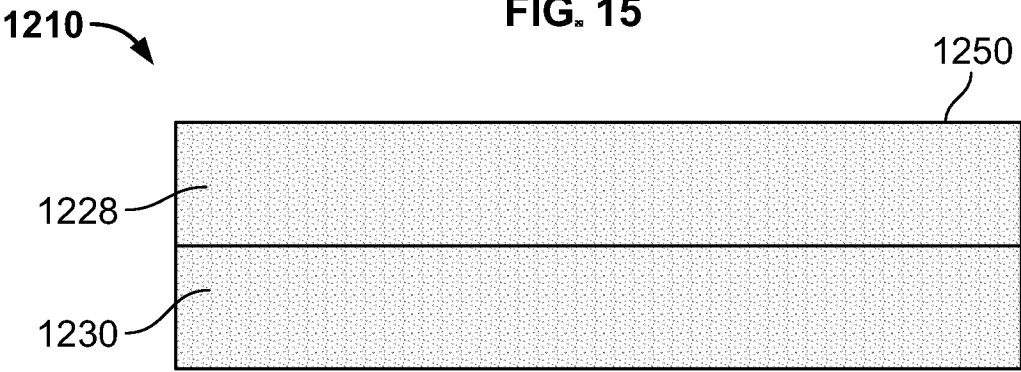


FIG. 16

1210

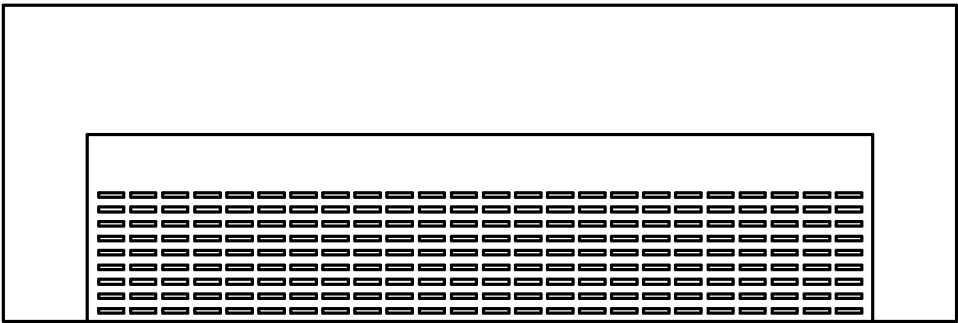


FIG. 17

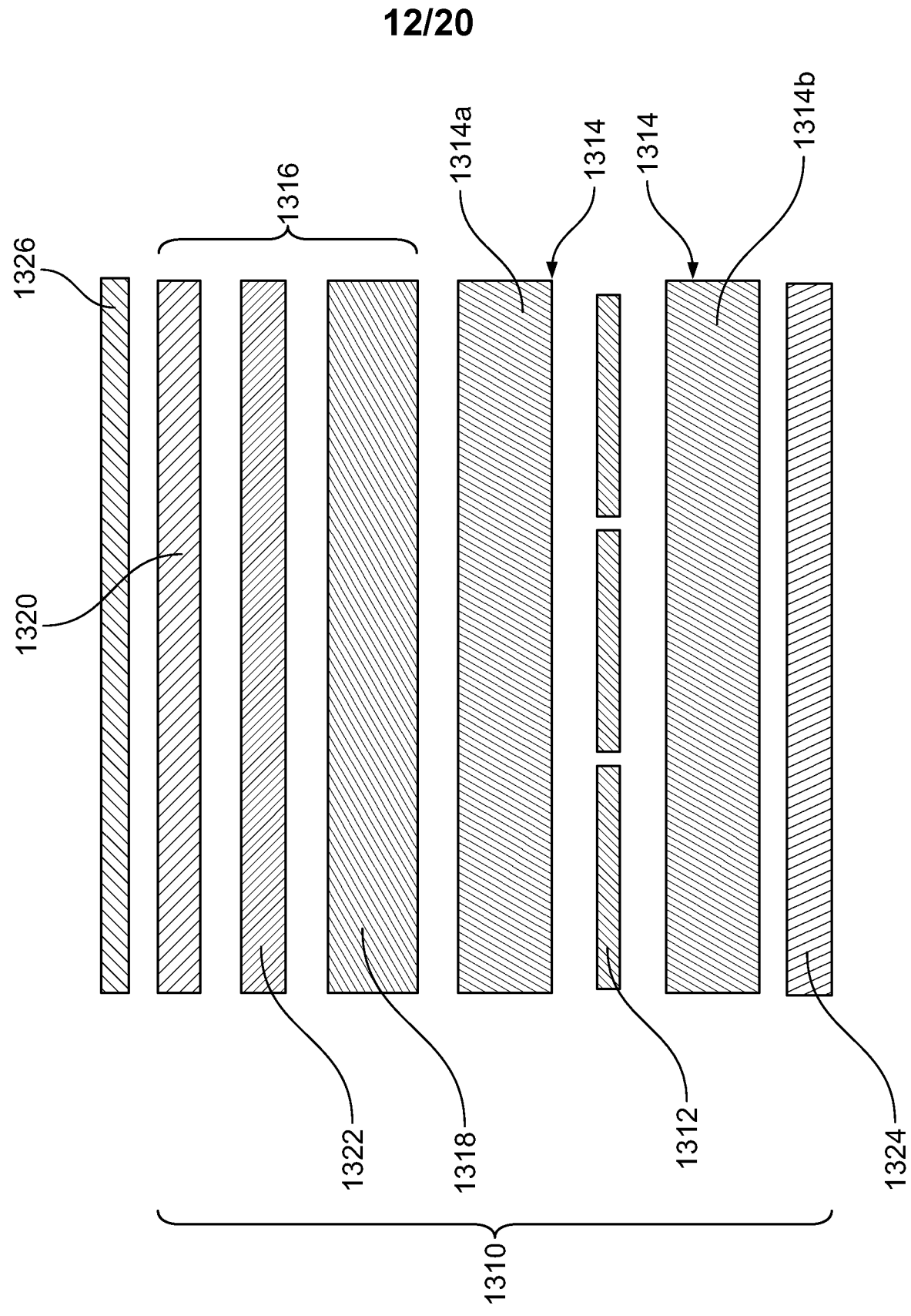


FIG. 18

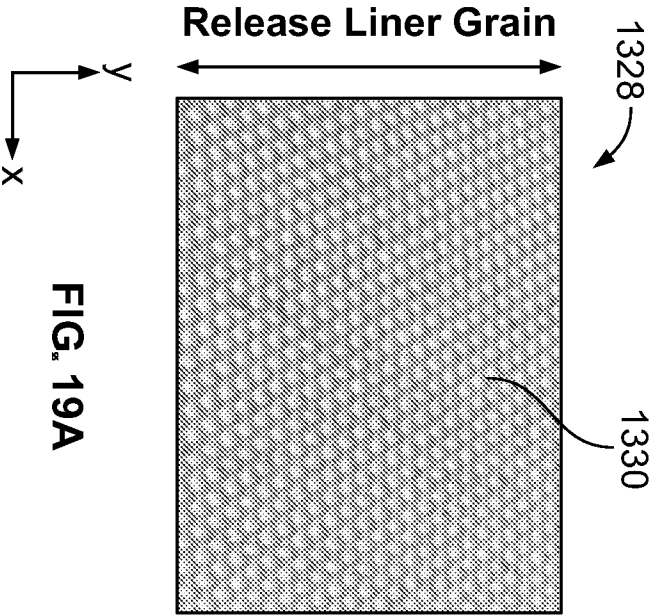


FIG. 19A

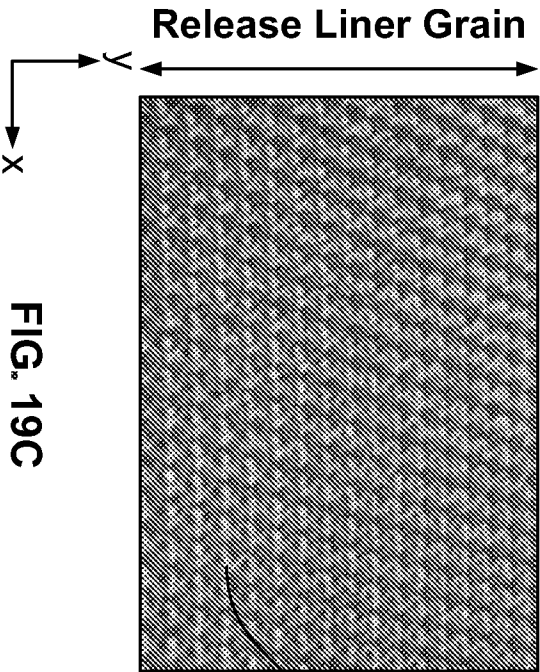


FIG. 19C

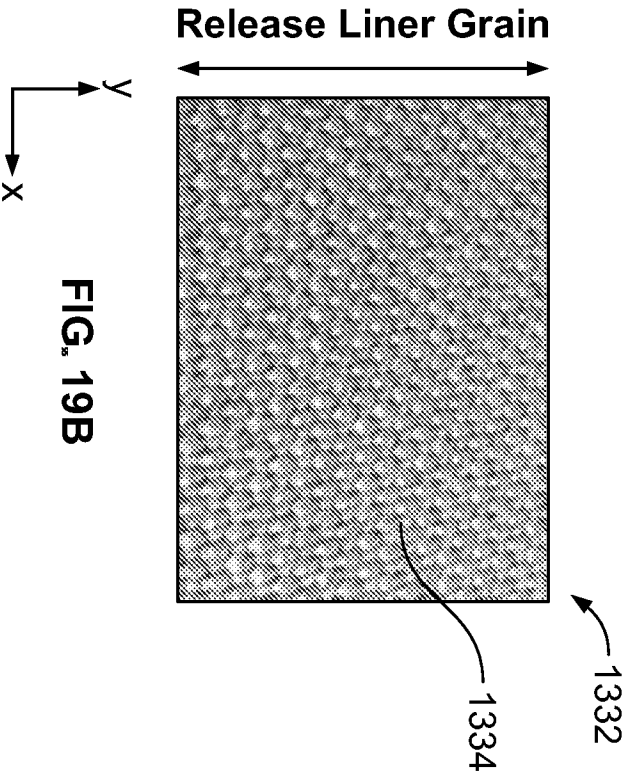


FIG. 19B

1336

1338

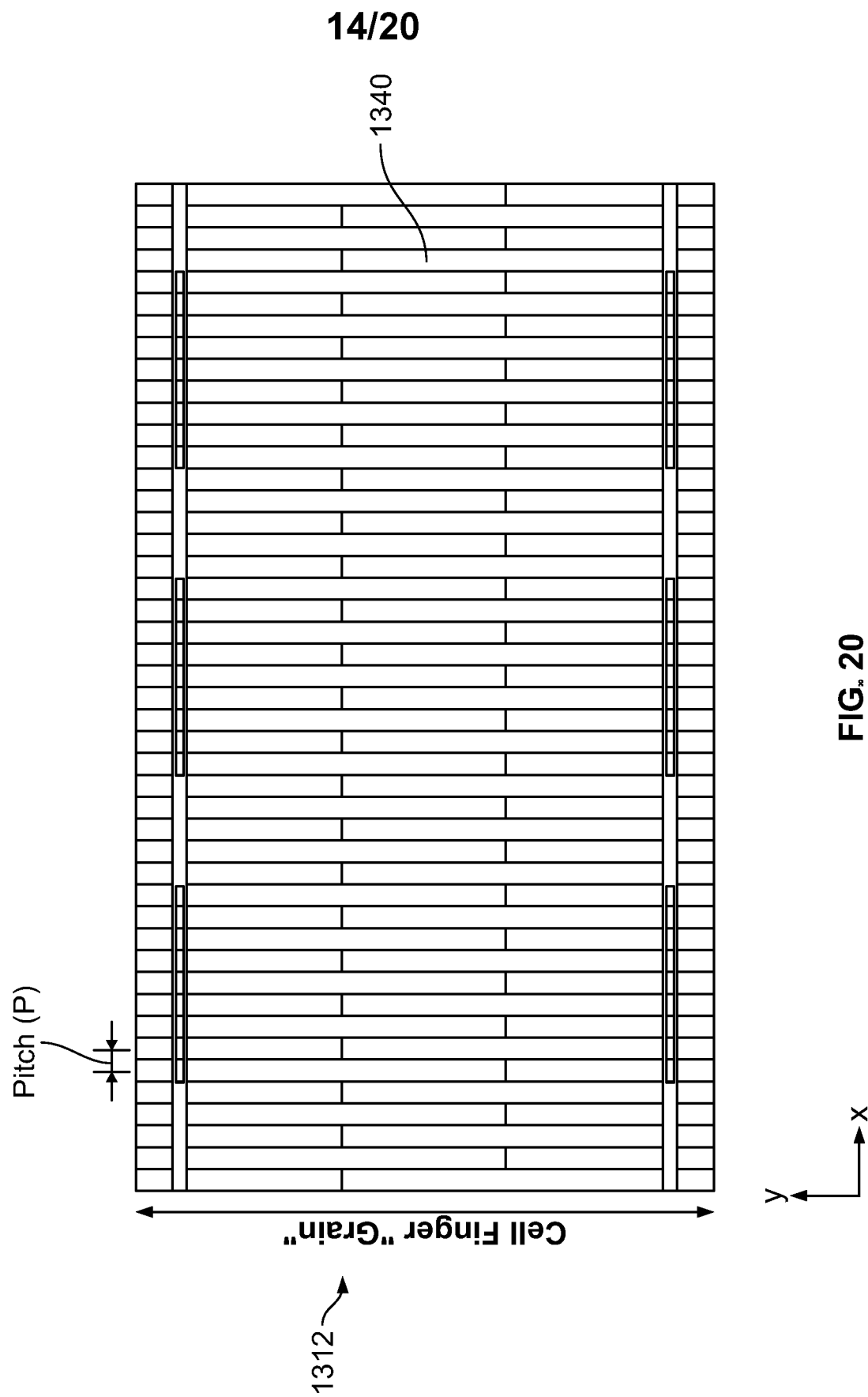


FIG. 20

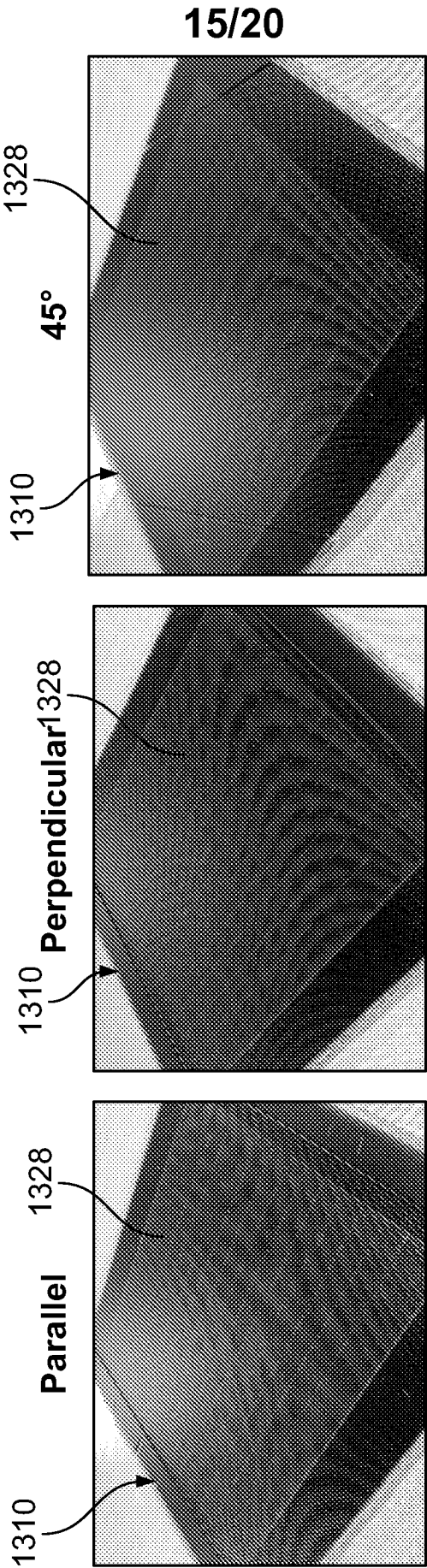


FIG. 21A

FIG. 21B

FIG. 21C

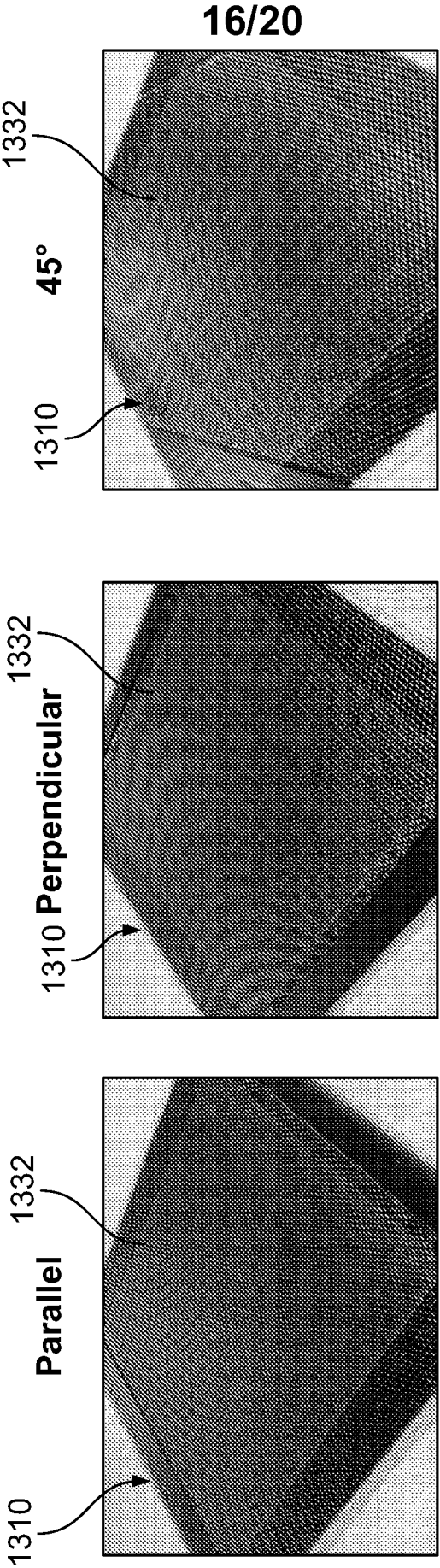


FIG. 22A

FIG. 22B

FIG. 22C

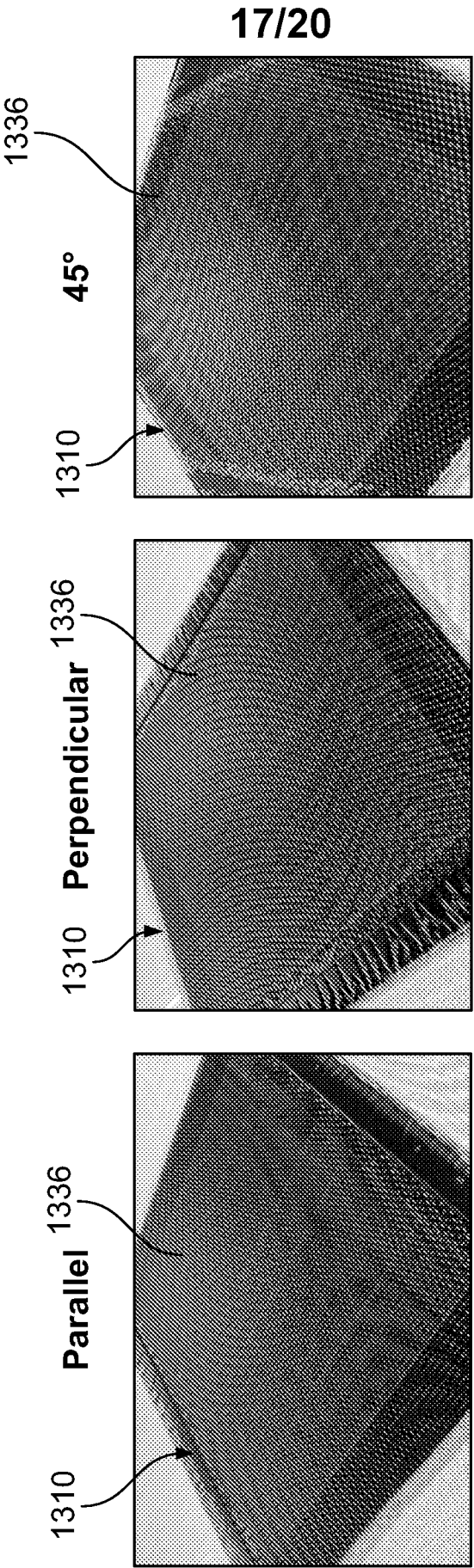


FIG. 23A

FIG. 23B

FIG. 23C

18/20

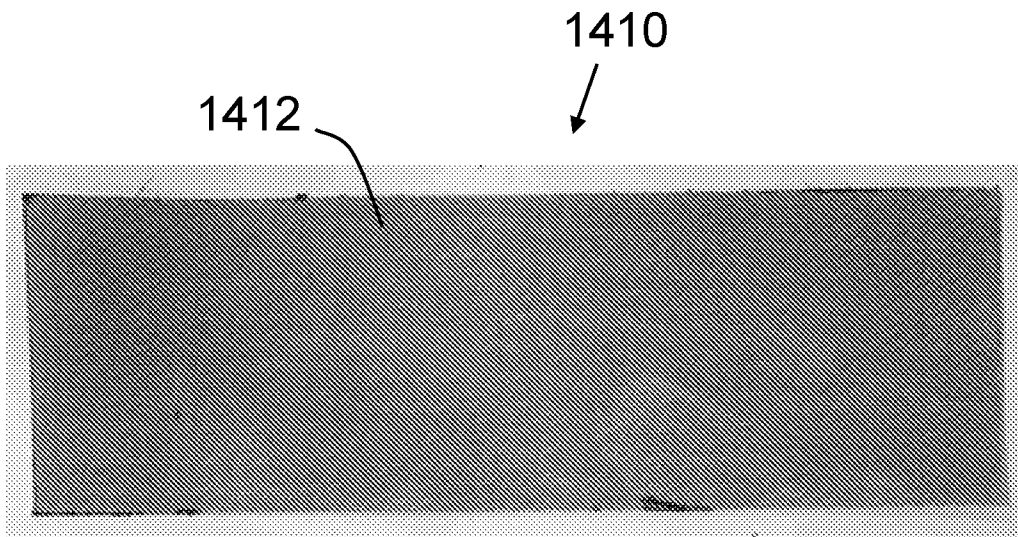


FIG. 24

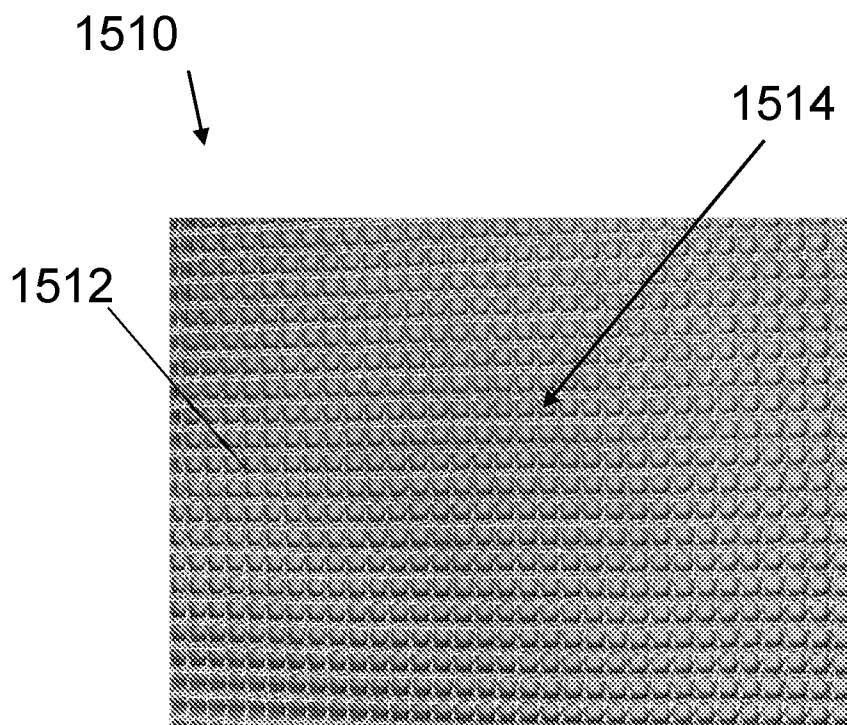


FIG. 25

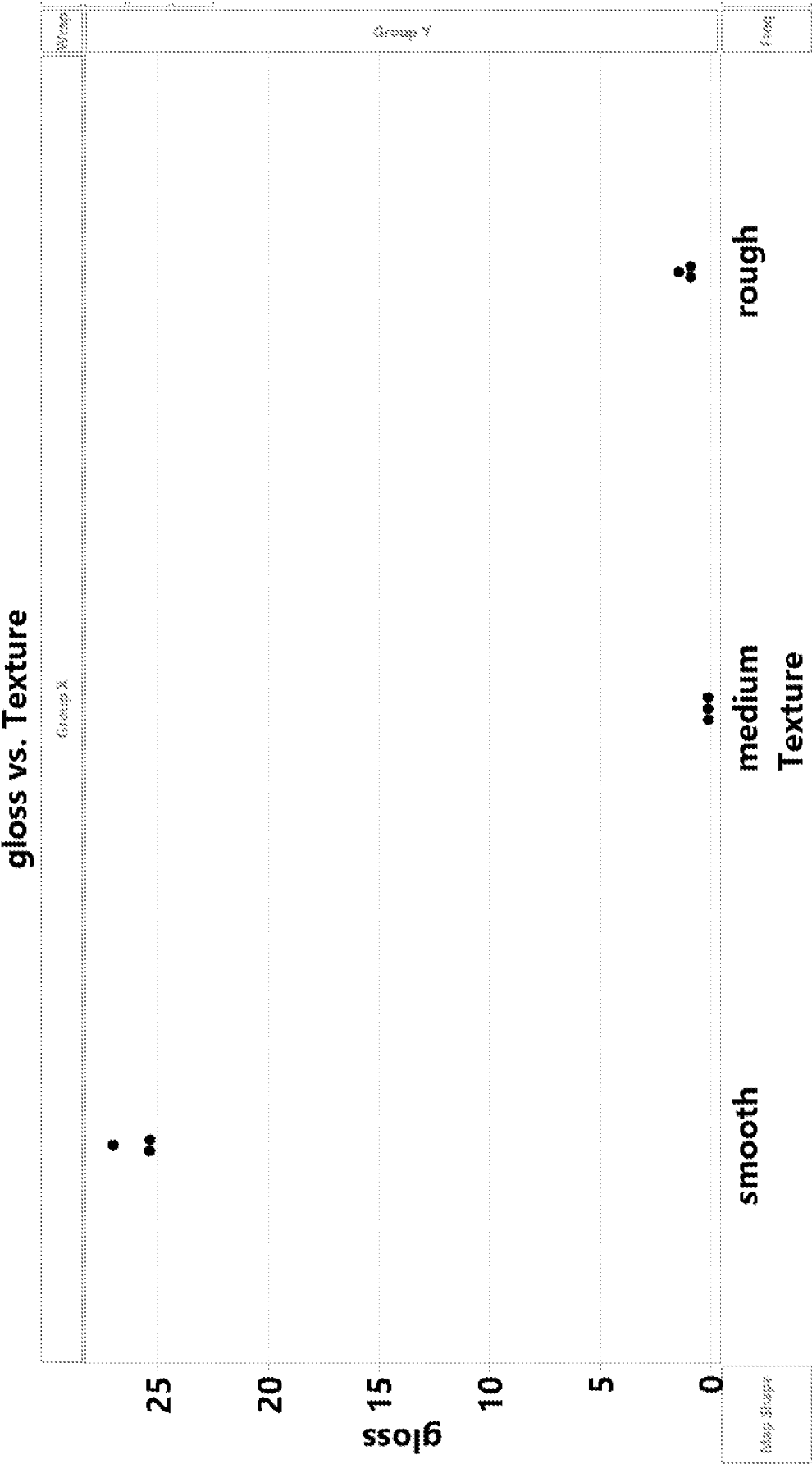


FIG. 26

20/20

1600
↓

1610

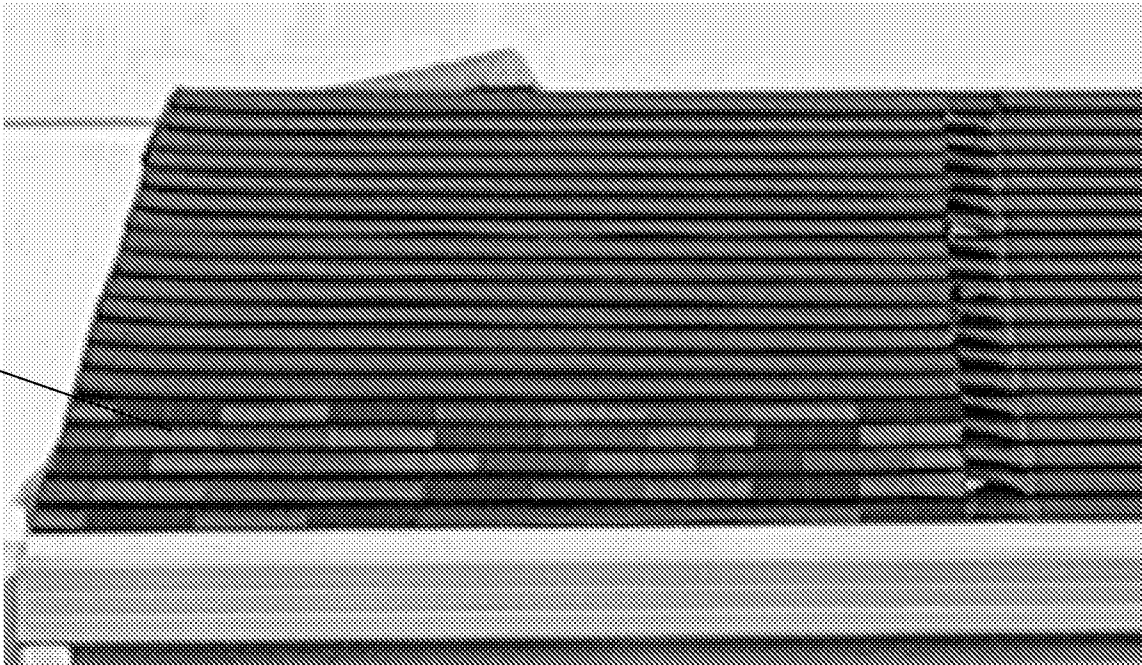


FIG. 27

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2022/032016

A. CLASSIFICATION OF SUBJECT MATTER

H02S 20/25(2014.01)i; **B32B 7/05**(2019.01)i; **B32B 27/08**(2006.01)i; **B32B 27/32**(2006.01)i; **B32B 27/12**(2006.01)i;
B32B 38/00(2006.01)i

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)

H02S 20/25(2014.01); B32B 27/00(2006.01); C08L 23/04(2006.01); E04D 13/00(2006.01); E04D 3/35(2006.01);
H01L 31/042(2006.01); H01L 31/044(2014.01); H01L 31/05(2006.01); H02S 30/10(2014.01)

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: roof, photovoltaic module, similar, pattern, multilayer, polymer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US 2006-0046084 A1 (LI-YING YANG et al.) 02 March 2006 (2006-03-02) Abstract; paragraphs 6, 34, 51-53; and claim 29.	1-20
A	US 2008-0105291 A1 (STEPHEN GEORGE PISKLAK et al.) 08 May 2008 (2008-05-08) Claims 1-20; and figures 1-7.	1-20
A	US 9441376 B2 (BEIJING APOLLO DING RONG SOLAR TECHNOLOGY CO., LTD.) 13 September 2016 (2016-09-13) Claims 1-5; and figures 1-5.	1-20
A	KR 10-2012-0028991 A (DOW GLOBAL TECHNOLOGIES LLC.) 23 March 2012 (2012-03-23) Claims 1-3; and figures 1-16.	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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“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

27 September 2022

Date of mailing of the international search report

27 September 2022

Name and mailing address of the ISA/KR

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Authorized officer

PARK, Hye Lyun

Telephone No. +82-42-481-3463

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/US2022/032016

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Information on patent family members

International application No.

PCT/US2022/032016

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