



(43) International Publication Date
22 September 2016 (22.09.2016)

(51) International Patent Classification:

B32B 3/04 (2006.01) *B32B 7/10* (2006.01)
B32B 3/26 (2006.01) *B32B 7/14* (2006.01)
B32B 7/06 (2006.01) *B32B 38/10* (2006.01)

(21) International Application Number:

PCT/US2016/021783

(22) International Filing Date:

10 March 2016 (10.03.2016)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/133,649 16 March 2015 (16.03.2015) 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, DK, DM,

DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
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PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, 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,
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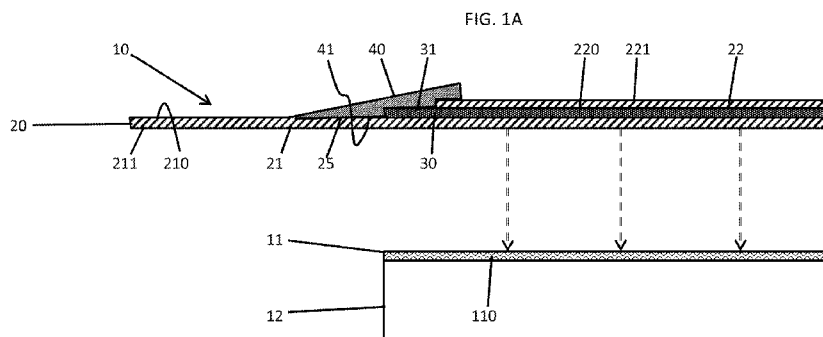
Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
- *of inventorship (Rule 4.17(iv))*

Published:

- *with international search report (Art. 21(3))*

(54) Title: BONDING PREPARATION PATCH



(57) Abstract: A bonding preparation patch for application to a resin treated surface is provided. The patch includes a strip having first and second portions, each of which has corresponding first and second sides. The strip is formed of resin porous material and is foldable such that the respective first sides of the first and second portions face each other. The patch further includes a resin barrier interposable between corresponding portions of the respective first sides and a tape including at least one adhesive side, which is securable relative to the first portion and disposable in contact with the second side of the second portion.

BONDING PREPARATION PATCH

BACKGROUND OF THE INVENTION

[0001] The subject matter disclosed herein relates to a bonding patch for providing a matte surface and, more particularly, to a bonding patch and method for using a bonding patch for an attachment to a treated surface of aircraft components.

[0002] Current airframe fabrication techniques involve the successive layering of laminates, which include carbon and fiberglass such as Aramid (Kevlar™), and which are bonded to one another by resins. When the laminates are coated with the resin, which is liquid and sticky in its uncured form, and heated, a strong bond between the laminates is achieved with the resin coated surface forming a non-sticky generally smooth surface.

[0003] In the particular instance wherein the laminates are bonded to form an airframe, such as that of an airplane or helicopter, there exists the further need to attach infrastructure to the sides of the airframe including the hardened laminate structures. For example, it is common to run electrical wiring around and along the surface structure of an airframe and to bond clips or other holding devices to the surface of the airframe through which a continuous electrical network may be run. However, in order to bond a clip or other holding device to the relatively smooth surface of the heat treated resin coated laminate, it is necessary to treat the surface so as to form a matte or otherwise non-smooth, abrasive surface in order to enhance the bonding ability of whatever glue or bonding material is used to attach the clip or other holding device to the epoxy resin coated surface.

[0004] It is both time and effort consuming to machine, or otherwise fashion, a matte surface onto the airframe after it has been assembled. In addition, post assembly, access to the surfaces in need of a matte finish may be obstructed.

BRIEF DESCRIPTION OF THE INVENTION

[0005] According to one aspect of the invention, a bonding preparation patch for application to a resin treated surface is provided. The patch includes a strip having first and second portions, each of which has corresponding first and second sides. The strip is formed of resin porous material and is foldable such that the respective first sides of the first and second portions face each other. The patch further includes a resin barrier interposable between corresponding portions of the respective first sides and a tape including at least one

adhesive side, which is securable relative to the first portion and disposable in contact with the second side of the second portion.

[0006] In accordance with additional or alternative embodiments, the resin porous material has a sufficient tensile strength to resist tearing upon separation from the resin treated surface.

[0007] In accordance with additional or alternative embodiments, the resin porous material is patterned as a negative of a desired pattern of surface features of the resin treated surface.

[0008] In accordance with additional or alternative embodiments, the resin porous material is configured to modify the surface features of the resin treated surface to have a bondability value of at least 10 inch-pounds/inch of width.

[0009] In accordance with additional or alternative embodiments, the resin porous material is patterned to mechanically modify the surface features of the resin treated surface.

[0010] In accordance with additional or alternative embodiments, the resin porous material is configured to chemically modify the resin treated surface.

[0011] In accordance with additional or alternative embodiments, the resin porous material includes woven material.

[0012] In accordance with additional or alternative embodiments, the resin barrier is flush with edges of the strip.

[0013] In accordance with additional or alternative embodiments, the resin barrier includes a non-bonding film material that forms a resin barrier and withstands cure temperatures.

[0014] In accordance with additional or alternative embodiments, the resin barrier includes a third portion of the strip.

[0015] In accordance with additional or alternative embodiments, the tape withstands cure temperatures.

[0016] In accordance with additional or alternative embodiments, the at least one adhesive side is disposable to contact the first side of the first portion.

[0017] In accordance with additional or alternative embodiments, digital representations formatted to be readable by a 3D printer, which, when acted upon by the 3D printer, cause the 3D printer to 3D print the strip, the resin barrier and the tape. According to another aspects of the invention, an airframe is provided and includes a structural component having a surface, resin disposed on the surface to form a resin treated surface and a bonding preparation patch for application to the resin treated surface such that once the resin is cured

the resin treated surface is pattern imprinted and possessed of a bondability value of at least 10 inch-pounds/inch of width. The patch includes a strip having first and second portions, each of which has corresponding first and second sides, the strip being formed of resin porous material, and foldable such that the respective first sides of the first and second portions face each other. The patch further includes a resin barrier interposable between corresponding portions of the respective first sides and a tape including at least one adhesive side, which is securable relative to the first portion and disposable in contact with the second side of the second portion.

[0018] According to yet another aspect of the invention, a method of forming an airframe is provided and includes resin treating a surface, forming a strip of resin porous material into a first portion and a second portion, applying the first portion to the resin treated surface, securably folding the second portion toward the first portion with a resin barrier interposed between the first and second portions, curing the resin treated surface and removing the strip from the cured surface.

[0019] In accordance with additional or alternative embodiments, the forming of the strip and the securably folding of the second portion toward the first portion are conducted prior to the resin treating of the surface.

[0020] In accordance with additional or alternative embodiments, the securably folding includes taping the second portion to the first portion.

[0021] In accordance with additional or alternative embodiments, the removing includes unsecuring the second portion from the first portion, unfolding the second portion away from the first portion and lifting the first portion away from the cured surface.

[0022] In accordance with additional or alternative embodiments, the resin porous material has a sufficient tensile strength to resist tearing upon separation from the resin treated surface.

[0023] In accordance with additional or alternative embodiments, the resin porous material includes woven material.

[0024] These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing

and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0026] FIG. 1A is a side view of a bonding preparation patch in accordance with embodiments;

[0027] FIG. 1B is a top down view of a portion of the bonding preparation patch of FIG. 1;

[0028] FIG. 2 is a perspective view of an initial stage of a bonding preparation method in accordance with embodiments;

[0029] FIG. 3 is a perspective view of an intermediate stage of a bonding preparation method in accordance with embodiments;

[0030] FIG. 4 is a perspective view of an intermediate stage of a bonding preparation method in accordance with embodiments;

[0031] FIG. 5 is a perspective view of an intermediate stage of a bonding preparation method in accordance with embodiments;

[0032] FIG. 6 is a perspective view of an intermediate stage of a bonding preparation method in accordance with embodiments;

[0033] FIG. 7 is a perspective view of a final stage of a bonding preparation method in accordance with embodiments;

[0034] FIG. 8 is a perspective view of a portion of the bonding preparation patch of FIG. 1 in accordance with alternative embodiments;

[0035] FIG. 9 is a top down view of a resin barrier and strip material in accordance with embodiments; and

[0036] FIG. 10 is a side view of the resin barrier and strip material of FIG. 9.

[0037] The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0038] As will be described below, a bonding preparation patch is provided and is formed of a strip of porous, woven material that is folded to form a flap with the non-flap portion laid generally flat against a resin surface. As a result, the resin soaks into, and partially through, the portion of the material laid flat against the resin. A barrier is provided to separate the flap and non-flap portions of the material which serves to prevent the resin from soaking through to the flap portion. The flap is then pressed flat and secured through the use of tape.

[0039] Once the resin is heat treated to become non-sticky, the tape may be removed exposing the flap portion of the material. By pulling on the flap, the non-flap portion of the material may be separated from the underlying resin treated surface. With the strip removed, the area of contact between the material and the resin treated surface exhibits a matte surface owing to the surface characteristics of the material which has been imprinted upon the resin treated surface. Such a bonding preparation patch may be distributed at any place about a resin treated surface and left in place until the resin treated surface has been assembled into an airframe or other structure.

[0040] With reference to FIGS. 1A and 1B and to FIGS. 2-7, a bonding preparation patch 10 is provided for application to, for example, a resin treated surface 11 of an airframe component 12 of an aircraft. The airframe component 12 may be any component of the aircraft (e.g., structural or otherwise). The patch 10 includes a strip 20. The strip 20 has a first portion 21 that has first and second opposite sides 210, 211 and a second portion 22 that also has first and second opposite sides 220, 221. As shown in FIG. 2, the strip 20 may be initially planarized such that the respective first sides 210 and 220 are co-planar and the respective second sides 211 and 221 are also co-planar. The strip 20 is disposable on the resin treated surface 11 such that the second side 211 of the first portion 21 impinges on the resin treated surface 11 and the first side 210 faces away from the resin treated surface 11.

[0041] The strip 20 is formed of resin porous material, such as a woven fabric material 23. This material 23 has a pattern that is defined as a negative of a desired pattern that is to be imprinted on the resin treated surface 11 (e.g., a matte finish so that the material 23 has to have a negative of a matte finish or a matrix of square or polygons so that the material 23 has to have a cross-linked, weave pattern). That is, once the strip 20 is disposed on the resin treated surface 11, the resin 110 provided thereon in an uncured, liquid and sticky form seeps or leaks through the first portion 21 of the strip 20 from the second side 211 to the first side 210. In doing so, the resin 110 assumes the negative (or imprinted or reverse) pattern of the material 23 pattern.

[0042] It is to be understood that the material 23 pattern and the chemistry of the resin and the material 23 can be variable for different applications and combinations.

[0043] As shown in FIGS. 1 and 3-5, the strip 20 further includes a resin barrier 30 and a tape 40 and is foldable along fold 24 such that the respective first sides 210 and 220 of the first and second portions 21 and 22 face each other with the resin barrier 30 interposable between corresponding portions of the respective first sides 210 and 220. The resin barrier 30 may be formed of fluorinated ethylene propylene (FEP) or another similar material such that

the presence of the resin barrier 30 prevents the resin 110 that has seeped or leaked through the first portion 21 from seeping or leaking from the first side 210 of the first portion 21 to any part of the second portion 22. Edges of the resin barrier 30 may be flush with corresponding edges of the strip 20 as shown in FIG. 4 however this is not necessary and, in some embodiments, the edges of the resin barrier 30 extend beyond the edges of the strip 20 or terminate short of the edges of the strip 20.

[0044] The tape 40 secures the second portion 22 in the folded condition with the resin barrier 30 in place. The application of the tape 40 can also serve as the application of force necessary to cause the resin 110 to seep or leak through the first portion 21 of the strip 20.

[0045] The tape 40 may be formed of fluoro peel tape or another similar material and includes at least one adhesive side 41 (see FIG. 1). This adhesive side 41 is securable relative to the first portion 21 and is disposable in contact with the second side 221 of the second portion 22. In accordance with embodiments, the adhesive side 41 adhesively contacts the second side 221 of the second portion 22, an exposed portion 31 of the resin barrier 30 and an exposed portion 25 of the first side 211 of the first portion 21. In accordance with alternative embodiments, the adhesive side 41 contacts with another laminate feature, such as a second layer of tape, which in turn contacts the first side of the first portion 21. Edges of the tape 40 may be flush with corresponding edges of the strip 20 as shown in FIG. 5 however this is not necessary and, in some embodiments, the edges of the tape 40 extend beyond the edges of the strip 20 or terminate short of the edges of the strip 20.

[0046] With the strip 20 being folded along the fold 24 such that the respective first sides 210 and 220 of the first and second portions 21 and 22 face each other and with the tape 40 securing the folding, the resin barrier 30 may be disposed proximate to or in an abutting condition with the fold 24. Thus, the resin barrier 30 may occupy an entirety or at least a substantial entirety of the space defined between the respective first sides 210 and 220. In this way, the resin barrier 30 is disposed to prevent all or substantially all of the resin 110 that has seeped or leaked through the first portion 21 from seeping or leaking from the first side 210 of the first portion 21 to any part of the second portion 22.

[0047] Once the patch 10 is formed and applied to the resin treated surface 11 such that the resin 110 seeps or leaks through the first portion 21, the resin 110 is cured. Such curing may be achieved by heat treatment, ultraviolet (UV) radiation treatment or another similar curing treatment. In any case, the resin 110 is cured and thus assumes the negative, reverse or imprinted pattern. At this point, as shown in FIG. 6, the tape 40 is removed, the

second portion 22 of the strip 20 is unfolded away from the resin barrier 30 and the resin barrier 30 is removed. Then, as shown in FIG. 7, the strip 20 is removed, pulled or lifted off of the resin treated surface 11 by a pulling force being applied to the second portion 22 to thus reveal the cured resin 110 and its imprinted matte finish pattern 111. This imprinted matte finish pattern 111 provides for a surface that is prepared for bonding and needs no further curing or machining in order to enhance the bonding ability of whatever glue or bonding material may be used to subsequently attach clips or other holding devices thereto.

[0048] In accordance with embodiments, the material 23 of the strip 20 is selective to have a sufficient tensile strength to resist tearing of the strip 20 upon separation of the strip 20 from the resin treated surface 11 as a result of the pulling force being applied to the second portion 22.

[0049] With reference to FIG. 8 and, in accordance with alternative embodiments, the resin barrier 30 may be provided as a part or component of the strip 20. In this case, the strip 20 may include the first portion 21, the second portion 22 and a third portion 26, which are arranged with the second portion 22 being sandwiched between the first and third portions 21 and 26. The third portion 26 is coated with FEP to provide for the resin barrier and the strip 20 is foldable twice along fold 24 and secondary fold 27 such that the third portion 26 ends up disposed between the first and second portions 21 and 22.

[0050] In accordance with further embodiments and, with reference to FIGS. 9 and 10, the material 23 of the strip 20 is configured to provide the resin treated surface 11, once cured, with a characteristic bondability value of at least 10 inch-pounds/inch of width or, more particularly, at least 13.6 inch-pounds/inch of width. This can be achieved by the formation/imprinting of the desired pattern on the resin treated surface 11. It may also be achieved by an additional mechanical and/or chemical embossment or modification of the resin treated surface 11 by the individual lines or threads 231 of the material 23. That is, the threads 231 may be disposed with a surface roughness 232 that leaves a corresponding roughness in the sides 233 of the surface features of the resin treated surface 11 as the strip 20 is pulled off of the resin treated surface 11. Similarly, the threads 231 may be coated with a certain chemical that mixes with the resin of the resin treated surface 11 during the above-described processing so that the resulting stickiness or bondability of the resin composite is increased. Similarly, the threads 231 may be made of a certain chemical that mixes with the resin of the resin treated surface 11 during the above-described processing so that the resulting stickiness or bondability of the resin composite is increased.

[0051] In accordance with further embodiments and, with continued reference to FIG. 10, a surface 300 of the resin barrier 30 contacts the resin that seeps or leaks through the first portion 21 of the strip 20 from the second side 211 to the first side 210. This surface 300 may be configured in a similar manner as the individual threads 231 of the material 23 to provide for mechanical or chemical embossments or modifications of the resin treated surface 11. That is, the surface 300 may be disposed with a surface roughness 301 that leaves a corresponding roughness in the upper surface 302 of the surface features of the resin treated surface 11 as the strip 20 is pulled off of the resin treated surface 11. Similarly, the surface 300 may be coated with a certain chemical that mixes with the resin of the resin treated surface 11 during the above-described processing so that the resulting stickiness or bondability of the resin composite is increased. Similarly, the surface 300 may be made of a certain chemical that mixes with the resin of the resin treated surface 11 during the above-described processing so that the resulting stickiness or bondability of the resin composite is increased.

[0052] In general, resin barrier 30 may not have sufficient tensile strength to resist tearing of the strip 20 upon separation of the strip 20 from the resin treated surface 11 as a result of the pulling force being applied to the second portion 22. That strength is provided by the strip 20. As a result, if the entire strip 20 were coated with a resin barrier and then folded once (along 24, for instance), the portion of the strip 20 that was remote from the resin would be easily separated (since there is resin barrier in contact with resin barrier) and act as a pull-tab. Such a pull tab would be of sufficient tensile strength to resist the tearing of the strip 20 upon separation of the strip 20 from the resin treated surface 11 as a result of the pulling force being applied to the second portion 22.

[0053] In accordance with further embodiments, it will be understood that the strip 20, the resin barrier 30 and the tap 40 can all be printed in three dimensions (3D printed). That is, digital representations of these features can be provided in a format that is readable by a given 3D printer. Thus, when the digital representation are input into and acted upon by the 3D printer, the digital representations are read by the 3D printer and cause the 3D printer to 3D print the strip 20, the resin barrier 30 and the tape 40.

[0054] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention.

Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

CLAIMS:

What is claimed is:

1. A bonding preparation patch for application to a resin treated surface, the patch comprising:
 - a strip having first and second portions, each of which has corresponding first and second sides, the strip being:
 - formed of resin porous material, and
 - foldable such that the respective first sides of the first and second portions face each other;
 - a resin barrier interposable between corresponding portions of the respective first sides; and
 - a tape including at least one adhesive side, which is securable relative to the first portion and disposable in contact with the second side of the second portion.
2. The patch according to claim 1, wherein the resin porous material has a sufficient tensile strength to resist tearing upon separation from the resin treated surface.
3. The patch according to claim 1, wherein the resin porous material is patterned as a negative of a desired pattern of surface features of the resin treated surface.
4. The patch according to claim 3, wherein the resin porous material is configured to modify the surface features of the resin treated surface to have a bondability value of at least 10 inch-pounds/inch of width.
5. The patch according to claim 3, wherein the resin porous material is patterned to mechanically modify the surface features of the resin treated surface.
6. The patch according to claim 3, wherein the resin porous material is configured to chemically modify the resin treated surface.
7. The patch according to claim 1, wherein the resin porous material comprises woven material.
8. The patch according to any of claims 1-7, wherein the resin barrier is flush with edges of the strip.
9. The patch according to any of claims 1-8, wherein the resin barrier comprises a non-bonding film material that forms a resin barrier and withstands cure temperatures.
10. The patch according to any of claims 1-9, wherein the resin barrier comprises a third portion of the strip.
11. The bonding preparation patch according to any of claims 1-10, wherein the tape withstands cure temperatures.

12. The bonding preparation patch according to any of claims 1-11, wherein at least one adhesive side is disposable to contact the first side of the first portion.

13. The bonding preparation patch according to any of claims 1-12, further comprising digital representations formatted to be readable by a 3D printer, which, when acted upon by the 3D printer, cause the 3D printer to 3D print the strip, the resin barrier and the tape.

14. An airframe, comprising:
a structural component having a surface;
resin disposed on the surface to form a resin treated surface; and
a bonding preparation patch for application to the resin treated surface such that once the resin is cured the resin treated surface is pattern imprinted and possessed of a bondability value of at least 10 inch-pounds/inch of width, the patch comprising:

a strip having first and second portions, each of which has corresponding first and second sides, the strip being:

formed of resin porous material, and
foldable such that the respective first sides of the first and second portions face each other;

a resin barrier interposable between corresponding portions of the respective first sides; and

a tape including at least one adhesive side, which is securable relative to the first portion and disposable in contact with the second side of the second portion.

15. A method of forming an airframe, comprising:
resin treating a surface;
forming a strip of resin porous material into a first portion and a second portion;
applying the first portion to the resin treated surface;
securably folding the second portion toward the first portion with a resin barrier interposed between the first and second portions;
curing the resin treated surface; and
removing the strip from the cured surface.

16. The method according to claim 15, wherein the forming of the strip and the securably folding of the second portion toward the first portion are conducted prior to the resin treating of the surface.

17. The method according to claim 15, wherein the securably folding comprises taping the second portion to the first portion.

18. The method according to any of claims 15-17, wherein the removing comprises:

unsecuring the second portion from the first portion;
unfolding the second portion away from the first portion; and
lifting the first portion away from the cured surface.

19. The method according to any of claims 15-18, wherein the resin porous material has a sufficient tensile strength to resist tearing upon separation from the resin treated surface.

20. The method according to any of claims 15-19, wherein the resin porous material comprises woven material.

FIG. 2

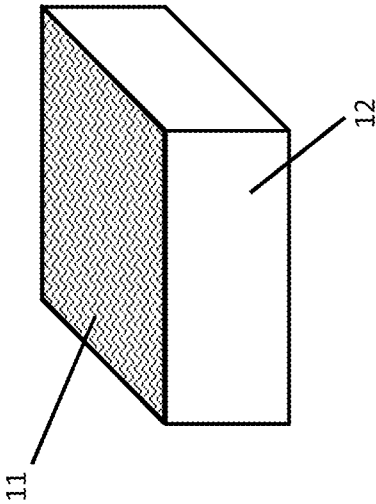


FIG. 3

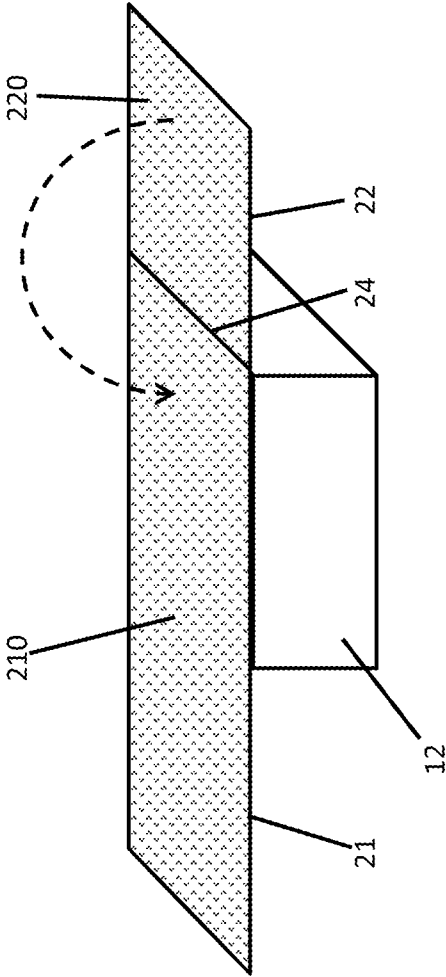


FIG. 4

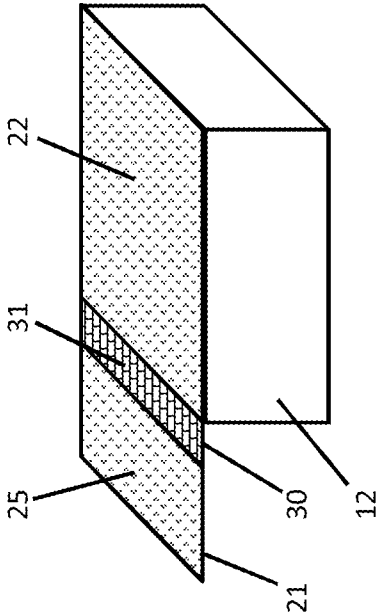


FIG. 5

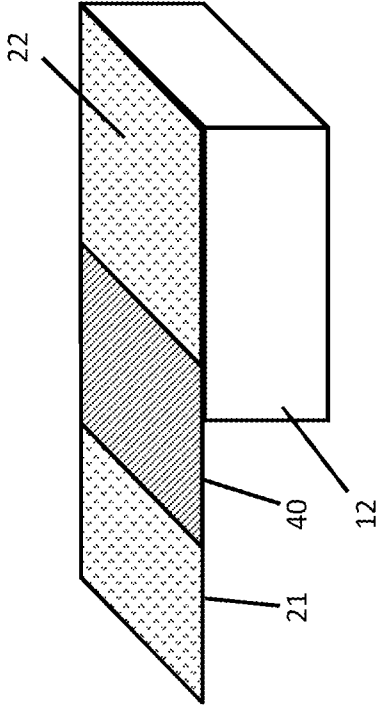


FIG. 6

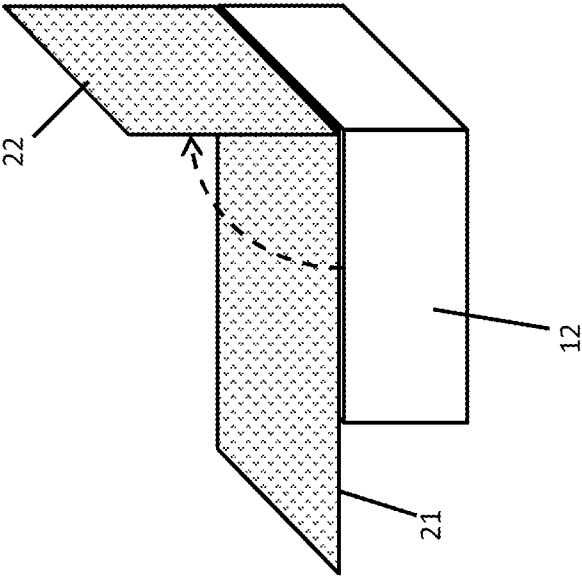


FIG. 7

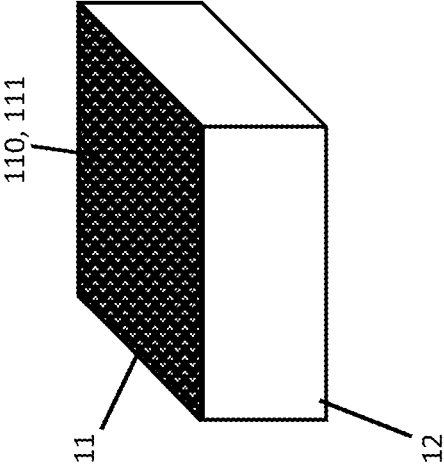


FIG. 8

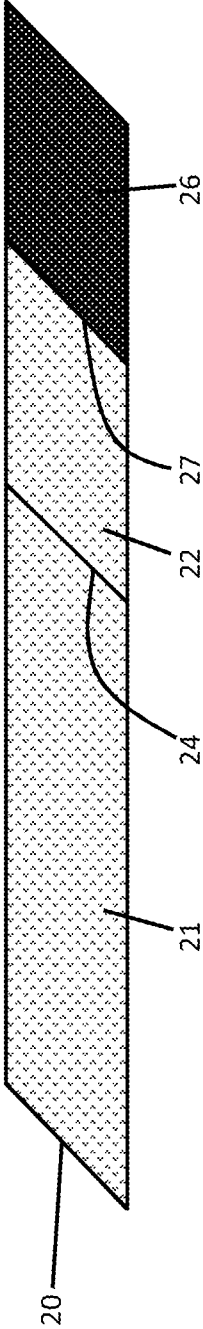


FIG. 9

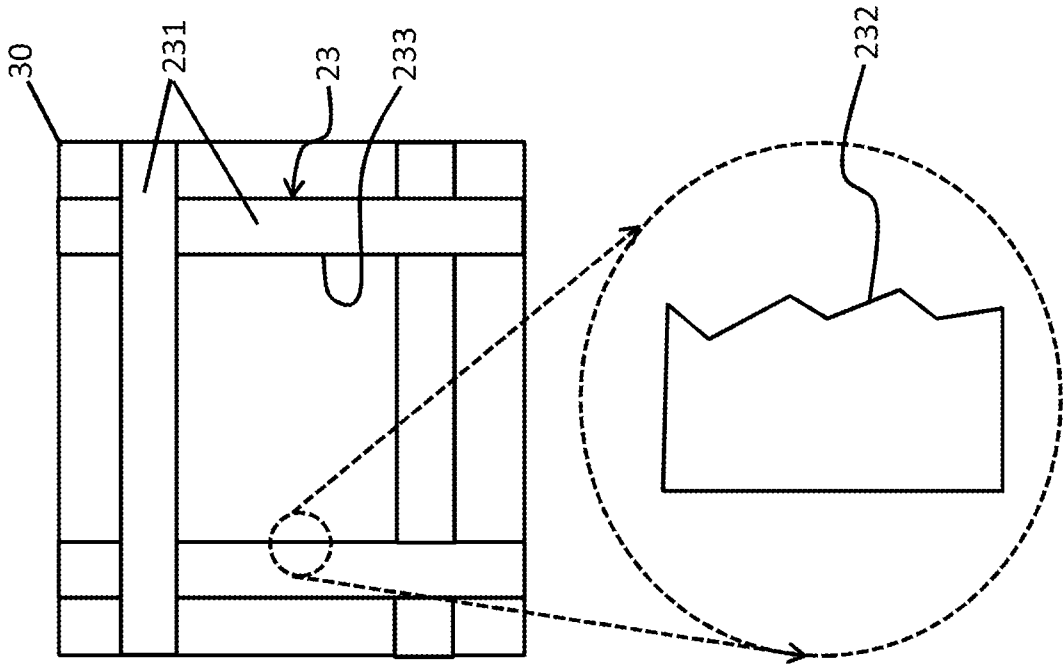
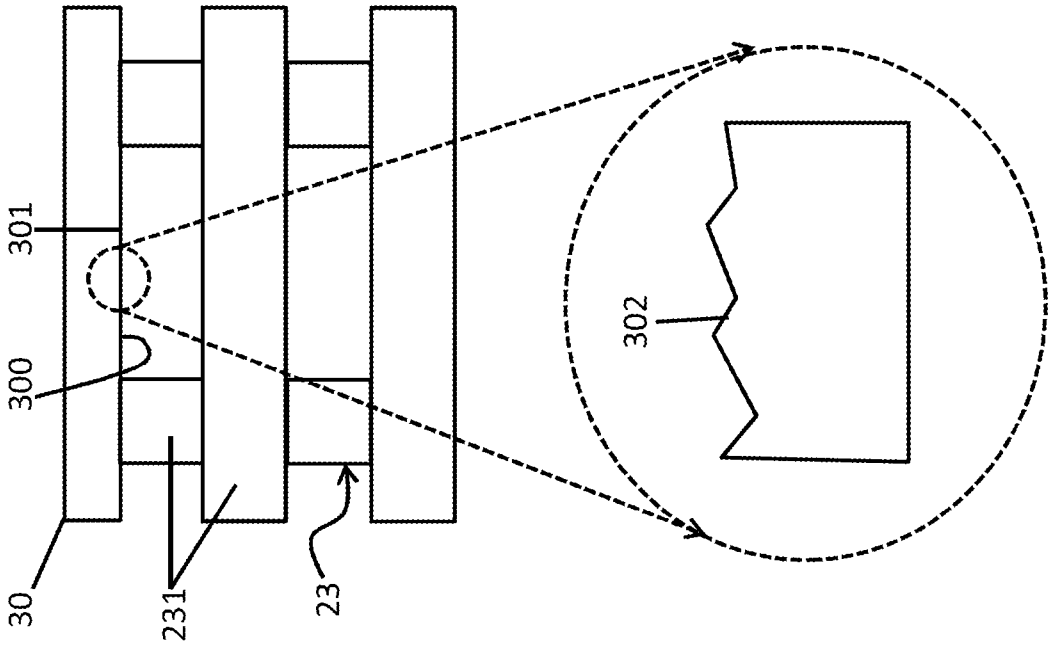


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US16/21783

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B32B 3/04, 3/26, 7/06, 7/10, 7/14, 38/10 (2016.01)

CPC - B32B 3/04, 3/26, 7/06, 7/14, 38/10; B29C 66/70, 66/7375

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)

IPC(8): B32B 3/04, 3/26, 7/06, 7/10, 7/14, 38/10 (2016.01)

CPC: B32B 3/04, 3/26, 7/06, 7/14, 38/10; B29C 66/70, 66/7375

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

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

PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); IP.com; Google/Google Scholar; EBSCO; patch, strip, bond, bind, adhere, prepare, surface, porous, resin, adhesive, barrier, block, tape, foldable, tensile strength, bondability, pattern, mechanically modify, chemically modify, woven, flush, edge, airframe, aircraft, airplane, aerospace, metal, unsecure, unfold, lift, peel

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013/0129957 A1 (CYTEC TECHNOLOGY CORP.) 23 May 2013; figure 1; paragraphs [0012]-[0013], [0015], [0017]-[0018], [0028]; claims 1, 21	1-7, 8/1-7, 14-17, 18/15-17
Y	US 6,827,893 B2 (CLUNE, W) 07 December 2004; abstract; column 8, lines 18-24, 62-66; column 9, lines 9-14; figures 1C, 3C; claim 15	1-7, 8/1-7, 14-17, 18/15-17
Y	US 2013/0280488 A1 (FLINN, BD) 24 October 2013; abstract; paragraphs [0015], [0020]; claim 8	3-6, 8/3-6
Y	US 2,569,954 A (RUEBENSAAL, CF) 02 October 1951; abstract; example IX	4, 8/4, 14,
Y	WO 1998/22069 (MINNESOTA MINING AND MANUFACTURING COMPANY) 28 May 1998; abstract; page 8, lines 11-17; page 15, lines 15-24; figure 2	18/15-17
A	US 2015/0056433 A1 (CYTEC INDUSTRIES INC.) 26 February 2015; entire document	1-7, 8/1-7, 14-17, 18/15-17
A	US 4,783,362 A (THORNTON, PB et al.) 08 November 1988; entire document	1-7, 8/1-7, 14-17, 18/15-17

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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

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

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

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

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search

06 May 2016 (06.05.2016)

Date of mailing of the international search report

02 JUN 2016

Name and mailing address of the ISA/

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Shane Thomas

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US16/21783

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

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 9-13, 19-20
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

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

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.