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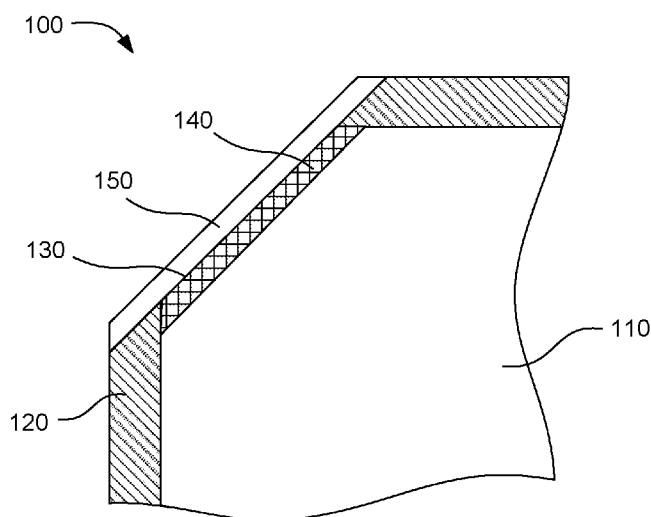


FIG. 1

(57) Abstract: The present disclosure is drawn to covers for electronic devices. In one example, a cover for an electronic device can include a metal cover substrate and a protective coating on a surface of the metal cover substrate. A chamfered edge including a chamfer at an edge of the metal cover substrate can cut through the protective coating to form an exposed metal cover substrate. A transparent passivation layer can be at the exposed metal cover substrate at the chamfered edge. An ink layer can be printed on the chamfered edge that also includes the transparent passivation layer.



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COVERS FOR ELECTRONIC DEVICES

BACKGROUND

[0001] There are several reasons that inkjet printing has become a popular
10 way of recording images on various media surfaces. Some of these reasons
include low printer noise, variable content recording, capability of high speed
recording, and multi-color recording. Additionally, these features can be obtained
at a relatively low price to consumers. Consumer demand can create pressure to
develop inkjet printing systems and inks that can print on a wide variety of media
15 quickly and with good image quality. Various types of specialty media have been
developed for use with inkjet printing to provide better performance or features in
certain printing applications.

BRIEF DESCRIPTION OF THE DRAWING

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[0002] FIG. 1 is a cross-sectional view illustrating an example cover for an
electronic device in accordance with examples of the present disclosure;

[0003] FIG. 2 is a cross-sectional view illustrating another example cover
for an electronic device in accordance with examples of the present disclosure;

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[0004] FIG. 3 is a top down view and a partial cross-sectional view of an
example cover for an electronic device in accordance with the present disclosure;

[0005] FIG. 4 is a cross-sectional view of an electronic device in
accordance with examples of the present disclosure;

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[0006] FIG. 5 is a flowchart illustrating an example method of making a
cover for an electronic device in accordance with examples of the present
disclosure; and

[0007] FIGS. 6A-6E are cross-sectional views showing another example method of making a cover for an electronic device in accordance with examples of the present disclosure.

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DETAILED DESCRIPTION

[0008] The present disclosure describes covers for electronic devices. In one example, a cover for an electronic device can include a metal cover substrate, a protective coating on a surface of the metal cover substrate, and a chamfered edge including a chamfer at an edge of the metal cover substrate. The chamfer can cut through the protective coating to expose the metal cover substrate at the chamfered edge. The cover can also include a transparent passivation layer at the chamfered edge where the metal cover substrate is exposed, as well as an ink layer printed over the transparent passivation layer at the chamfered edge. In some examples, the metal cover substrate can include aluminum, magnesium, lithium, titanium, zinc, niobium, stainless steel, or an alloy thereof. In a further example, the metal cover substrate can include a micro-arc oxidation layer on a surface of the metal cover substrate that is likewise chamfered. In yet another example, the protective coating can be a paint coating comprising a colorant and a polymeric binder. In an alternative example, the protective coating can be an electrophoretic deposition coating including a polymer binder, a pigment, and a dispersant. In further examples, the transparent passivation layer can include a chelating agent and a metal ion, a chelated metal complex of the chelating agent and the metal ion, an oxide of the metal ion, or a combination thereof, wherein the metal ion is an aluminum ion, an indium ion, a nickel ion, a chromium ion, a tin ion, or a zinc ion. In another example, the ink layer can include a colorant and a polymeric binder. In still another example, the cover can include a second chamfered edge and a second ink layer printed over the second chamfered edge, wherein the ink layer and the second ink layer are of a different color relative to one another.

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[0009] The present disclosure also extends to electronic devices. In one example, an electronic device can include an electronic component and a cover

enclosing the electronic component. The cover can include a metal cover substrate, a protective coating on a surface of the metal cover substrate, and a chamfered edge including a chamfer at an edge of the metal cover substrate. The chamfer can cut through the protective coating to expose the metal cover substrate at the chamfered edge. The cover can also include a transparent passivation layer at the chamfered edge where the metal cover substrate is exposed, and an ink layer printed over the transparent passivation layer at the chamfered edge. In some examples, the electronic device can be a laptop, tablet computer, smartphone, an e-reader, or a music player. In further examples, the chamfered edge can be located at an edge of a touchpad, an edge of a fingerprint scanner, an outer edge of the cover, an edge of a sidewall, or an edge of a logo. In a particular example, the cover can include multiple chamfered edges with multiple ink layers having multiple colors printed over the multiple chamfered edges.

[0010] The present disclosure also extends to methods of making covers for electronic devices. In one example, a method of making a cover for an electronic device can include forming a metal cover substrate, applying a protective coating over a surface of the metal cover substrate, and chamfering an edge of the metal cover substrate to form a chamfered edge that cuts through the protective coating and forms an exposed metal edge. The method can further include treating the chamfered edge with a transparent passivation treatment to form a transparent passivation layer at exposed metal at the chamfered edge, and printing an ink over the chamfered edge which includes the transparent passivation layer. In a particular example, the ink can be printed by an inkjet printer. In a further example, the method can also include chamfering a second edge of the metal cover substrate and printing a second ink over the second chamfered edge, wherein the ink and the second ink have different colors.

Covers for Electronic Devices

[0011] The present disclosure describes covers for electronic devices that can be strong and lightweight and have a decorative appearance. In some cases, light metal materials can be used to make covers for electronic devices.

Generally, light metals can include aluminum, magnesium, titanium, lithium, niobium, zinc, and alloys thereof. Covers can also be made from stainless steel in some cases. These materials can have useful properties, such as low weight, high strength, and an appealing appearance. However, some of these metals can be easily oxidized at the surface, and may be vulnerable to corrosion or other chemical reactions at the surface. For example, magnesium or magnesium alloys in particular can be used to form covers for electronic devices because of the low weight and high strength of magnesium. Magnesium can have a somewhat porous surface that can be vulnerable to chemical reactions and corrosion at the surface. In some examples, magnesium or magnesium alloy can be treated by micro-arc oxidation to form a layer of protective oxide at the surface. This protective oxide layer can increase the chemical resistance, hardness, and durability of the magnesium or magnesium alloy. However, micro-arc oxidation can also create a dull appearance instead of the original luster of the metal.

[0012] The present disclosure describes covers for electronic devices that can utilize the above metals for their favorable properties and at the same time the metals can be protected from corrosion. Furthermore, the covers can have an attractive appearance. In some cases, it can be desirable to chamfer certain edges of the cover for ergonomics and/or to enhance the appearance of the cover. Some examples of edges that may be chamfered can include an edge surrounding a track pad on a lap top, an edge surrounding a fingerprint scanner, an outer edge of a smartphone housing, and so on. The covers described herein can include a chamfered edge that can have a customized appearance such as a metallic luster appearance, a colored metallic luster appearance, or an opaque colored appearance.

[0013] In certain examples, the cover can have a protective coating such as a paint coating or an electrophoretic deposition coating. The chamfer can cut through the protective coating to expose the metal of the cover substrate below. After the metal is exposed at the chamfered edge, the metal can be treated with a transparent passivation treatment to form a transparent passivation layer at the exposed metal. After this, an ink can be printed over the chamfered edge. In various examples, the ink can be transparent, semi-transparent, or opaque. Thus,

the chamfered edge can have a natural metallic luster appearance, a colored metallic appearance, or an opaque colored appearance depending on the type of ink printed onto the chamfered edge. The color of the chamfered edge can be customized and in some cases the color of the chamfered edge can be selected to contrast with or compliment the color of the protective coating on the cover substrate.

[0014] FIG. 1 shows an example cover 100 for an electronic device. The cover includes a metal cover substrate 110 with a protective coating 120 on a surface of the metal cover substrate. An edge 130 of the cover is chamfered, whereby the chamfer cuts through the protective coating to expose the metal cover substrate. A transparent passivation layer 140 is formed at the exposed metal cover substrate at the chamfered edge. An ink layer 150 is then printed over the chamfered edge, including at where the transparent passivation layer is formed on exposed metal. The ink layer can be also applied to other chamfered layers, such as the protective coating in this example, and in some examples, to other layers that may also be present on the metal cover substrate, e.g., micro-arc oxidation layer (see FIG. 2) or other colored, translucent, or transparent protective layers that may be present.

[0015] As shown in FIG. 1, in this example an edge of the cover is chamfered by cutting away material along a 90° angled edge at a 45° angle so that the 90° edge is replaced by a sloped surface at 45°. Accordingly, as used herein, “chamfer” refers to the action of cutting away an edge where two faces meet to form a sloping face transitioning between the two original faces. In some cases, the term “chamfered edge” can refer to the entire transition area between the original faces that metal at the edge before chamfering together with the sloped face created by the chamfering. In other cases, the term “chamfered edge” may refer specifically to the sloped face created by the chamfering. In many cases, the original edge can be a 90° angle edge, and the chamfer can create a sloping face at a 45° angle. However, in some examples the original edge can have a different angle and the chamfer can create a sloping surface with a different angle. In further examples, chamfering can be performed using a milling machine with a cutting bit oriented to cut away the edge and create the sloped

surface of the chamfered edge. In other examples, the chamfer can be performed by laser cutting, water jet cutting, sanding, or any other suitable method.

[0016] As mentioned above, in some examples the metal cover substrate can be treated by micro-arc oxidation. The micro-arc oxidation treatment can be performed before the metal cover substrate is coated with the protective layer. FIG. 2 shows an example cover 200 for an electronic device in which the metal cover substrate 210 includes a micro-arc oxidation layer 212. The metal cover substrate is coated with a protective coating 220 on the micro-arc oxidation layer. The chamfered edge 230 is then formed, which cuts through both the protective coating layer and the micro-arc oxidation layer in this example. A transparent passivation layer 240 is formed at the exposed metal of the metal cover substrate at the chamfered edge. An ink layer 250 is then printed over the chamfered edge.

[0017] Depending on the shape and design of a cover for an electronic device, the cover may have many different edges. Any of these edges can be chamfered depending on the desired final appearance of the cover. More particularly, in some examples the metal cover substrate (including either the entire substrate, a portion of the substrate, or multiples portions of the substrate) can be coated with a protective coating. Then any edge or multiple edges can be chamfered such that the chamfer cuts through the protective coating and exposes the metal cover substrate. The chamfered edges can be treated with a passivation treatment to form a transparent passivation layer at the exposed metal cover substrate. Ink layers can be printed on the chamfered edges using a variety of colors of ink. In certain examples, a cover can include multiple different chamfered edges that can be printed with different colors of ink.

[0018] FIG. 3 shows another example cover 300 for an electronic device. This example is a top cover for the keyboard portion of a laptop (sometimes referred to as a "laptop cover C"). The cover includes key openings 360 for the keyboard buttons (not shown) to be positioned therethrough, hinge recesses 362 to receive a hinge (not shown), a track pad opening 364 to receive a track pad (not shown), and a fingerprint scanner opening 366 to receive a fingerprint scanner (not shown). These are merely examples of structures that may be present, and are illustrative of many of a number of other structural components

used with this type of top cover. The cover is mostly made up of a metal cover substrate coated with a protective coating 320. The metal cover substrate is not directly visible in this example because it is covered by the protective coating. In this example, chamfered edges have been formed at three different locations: a track pad chamfered edge 330 surrounding the track pad opening, a fingerprint scanner chamfered edge 332 surrounding the fingerprint scanner opening, and a rear chamfered edge 334 along the rear edge of the cover near the hinge. Each of these chamfered edges is treated with a passivation treatment to form transparent passivation layers (not visible in the figure) and then printed with ink to form ink layers 350, 352, 354 over the chamfered edges. The ink layers can be the same color or different colors.

[0019] To show the various materials in this example more clearly, a partial cross-sectional view is shown as shown along plane “A” designated further by the dashed and dotted lines/arrows. This cross-sectional view shows the chamfered edge 330 bordering the track pad opening 364. The chamfer cuts through the protective coating layer 320 and the metal cover substrate 310. The transparent passivation layer 340 is formed at the exposed metal cover substrate. The ink layer 350 is then printed over the chamfered edge. As shown in the figure, in this example the chamfered edge includes a sloping face that slopes downward toward the track pad opening. When the cover is assembled with other components to make a complete laptop, this chamfered edge can provide a more comfortable edge around the track pad compared to a sharp 90° edge. Similarly, the chamfered edge around the fingerprint scanner can slop downward toward the fingerprint scanner in some examples.

[0020] As used herein, “cover” refers to the exterior shell of an electronic device. In other words, the cover contains the internal electronic components of the electronic device. The cover is an integral part of the electronic device. The term “cover” is not meant to refer to the type of removable protective cases that are often purchased separately for an electronic device (especially smartphones and tablets) and placed around the exterior of the electronic device. Covers as described herein can be used on a variety of electronic devices. For example, laptop computers, smartphones, tablet computers, and other electronic devices

can include the covers described herein. In various examples, the metal cover substrates for these covers can be formed by molding, casting, machining, bending, working, stamping, or another process. In one example, a metal cover substrate can be milled from a single block of metal. In other examples, the cover
5 can be made from multiple panels. For example, laptop covers sometimes include four separate cover pieces forming the complete cover of the laptop. The four separate pieces of the laptop cover are often designated as cover A (back cover of the monitor portion of the laptop), cover B (front cover of the monitor portion), cover C (top cover of the keyboard portion) and cover D (bottom cover of
10 the keyboard portion). Covers can also be made for smartphones and tablet computers with a single metal piece or multiple metal panels.

[0021] As used herein, a layer that is referred to as being “on” a lower layer can be directly applied to the lower layer, or an intervening layer or multiple intervening layers can be located between the layer and the lower layer.
15 Generally, the covers described herein can include a metal cover substrate and a protective coating can be applied on the metal cover substrate. Accordingly, a layer that is “on” a lower layer can be located further from the metal cover substrate. However, in some examples there may be other intervening layers such as a primer layer underneath the protective layer. Furthermore, the
20 protective layer itself may include multiple layers, such as a base layer, a topcoat layer, and any other intervening layers. In some examples, the protective coating and any other layers may be applied to an exterior surface of the metal cover substrate. Thus, a “higher” layer applied “on” a “lower” layer may be located farther from the metal cover substrate and closer to a viewer viewing the cover
25 from the outside. In further examples, the protective coating can be applied to all surfaces of the metal cover substrate.

[0022] It is noted that when discussing covers for electronic devices, the electronic devices themselves, or methods of making covers for electronic devices, such discussions can be considered applicable to one another whether
30 or not they are explicitly discussed in the context of that example. Thus, for example, when discussing the metals used in the metal cover substrate in the context of one of the example covers, such disclosure is also relevant to and

directly supported in the context of the electronic devices and/or methods, and *vice versa*. It is also understood that terms used herein will take on their ordinary meaning in the relevant technical field unless specified otherwise. In some instances, there are terms defined more specifically throughout or included at the end of the present disclosure, and thus, these terms are supplemented as having a meaning described herein.

Electronic Devices

[0023] A variety of electronic devices can be made with the covers described herein. In various examples, such electronic devices can include various electronic components enclosed by the cover. As used herein, “encloses” or “enclosed” when used with respect to the covers enclosing electronic components can include covers completely enclosing the electronic components or partially enclosing the electronic components. Many electronic devices include openings for charging ports, input/output ports, headphone ports, and so on. Accordingly, in some examples the cover can include openings for these purposes. Certain electronic components may be designed to be exposed through an opening in the cover, such as display screens, keyboard keys, buttons, track pads, fingerprint scanners, cameras, and so on. Accordingly, the covers described herein can include openings for these components. Other electronic components may be designed to be completely enclosed, such as motherboards, batteries, sim cards, wireless transceivers, memory storage drives, and so on. Additionally, in some examples a cover can be made up of two or more cover sections, and the cover sections can be assembled together with the electronic components to enclose the electronic components. As used herein, the term “cover” can refer to an individual cover section or panel, or collectively to the cover sections or panels that can be assembled together with electronic components to make the complete electronic device.

[0024] FIG. 4 shows a cross-sectional schematic view of an example electronic device 400 in accordance with examples of the present disclosure. This example includes a top cover 402 and a bottom cover 404 enclosing an electronic component 470. The top cover includes a metal cover substrate 410 with a

protective coating 420. Two chamfered edges 430, 432 are formed by chamfers that cut through the protective coating and expose the metal cover substrate. Transparent passivation layers 440, 442 are formed at the exposed metal cover substrate at the chamfered edges and ink layers 450, 452 are printed over the chamfered edges.

[0025] In further examples, the electronic device can be a personal computer, a laptop, a tablet computer, an e-reader, a music player, a smartphone, a mouse, a keyboard, or a variety of other types of electronic devices. In certain examples, the chamfered edge or edges can be located in decorative locations on the cover. Some examples include chamfered edges around track pads, around fingerprint scanners, at outer edges of the cover, at an edge of a sidewall, at an edge of a logo, and so on.

Methods of Making Covers for Electronic Devices

[0026] In some examples, the covers described herein can be made by first forming the metal cover substrate. This can be accomplished using a variety of processes, including molding, forging, casting, machining, stamping, bending, working, and so on. The metal cover substrate can be made from a variety of metals. In certain examples, the metal cover substrate can include aluminum, magnesium, lithium, titanium, zinc, niobium, stainless steel, or an alloy thereof. As mentioned above, in some examples the metal cover substrate can be a single piece while in other examples the metal cover substrate can include multiple pieces that each make up a portion of the cover. Additionally, in some examples the metal cover substrate can be a composite made up of multiple metals combined, such as having layers of multiple different metals or panels or other portions of the metal cover substrate being different metals.

[0027] A protective coating can be applied to a surface of the metal cover substrate. In some examples, the protective coating can be applied to any surface of the metal cover substrate, including fully or partially covering a single surface, fully or partially covering multiple surfaces, or fully or partially covering the metal cover substrate as a whole. The protective coating can be applied by any suitable application method.

[0028] In certain examples, the protective coating can be either a paint-type coating composition or an electrophoretic coating. In one example, a paint-type coating composition can be a liquid solution or dispersion including a colorant and a polymeric binder. The coating composition can be applied to the cover by any suitable method such as spraying, dip coating, and so on. In another example, the protective coating can be formed by electrophoretically depositing a coating composition including a polymeric binder, a pigment, and a dispersant.

[0029] The chamfered edges can be formed on an edge of the metal cover substrate coated with the protective coating. In various examples, chamfered edges can be formed at any edge or combination of edges on the cover. The chamfered edge can vary in depth. The term "depth" of chamfered edges refers to the amount of the edge that is cut away by the chamfering process. The depth of the chamfer can be stated in terms of the distance from the original edge of the cover to the edge of the sloped surface created by the chamfering. In various examples, the chamfer can be from about 0.1 mm to about 1 cm deep. In other examples, the chamfer can be from about 0.2 mm to about 5 mm deep. As stated above, in some examples the chamfer can be symmetrical so that the same amount of material is removed on both faces of the cover that meet at the chamfered edge. In a symmetrical chamfering of a 90° edge, the new sloped surface created by the chamfering is at a 45° angle with respect to the original faces of the cover. However, in other examples, the chamfer can be asymmetrical so that the angle of the sloped surface is different with respect to each of the original faces of the cover. The examples of the depth of the chamfer described above can refer to either side of the chamfer in the case of an asymmetrical chamfer.

[0030] The chamfered edge can be formed using any suitable process that can remove material at the edge of the cover and produce a sloped surface in place of the original edge. In some examples, the chamfer can be formed using a CNC machine such as a milling machine, a router, a laser cutter, a water jet cutter, a sander, a file, or other methods.

[0031] A transparent passivation can be formed on the exposed metal cover substrate after chamfering the edge. In some examples, this can be

accomplished using a passivation treatment. Some passivation treatments may include immersing the cover in a passivation treatment bath, so that all surfaces of the cover are contacted by reagents for the passivation treatment. However, in some examples the passivation treatment may affect the exposed metal cover substrate while having no effect on the surfaces that are coated with the protective coating. Transparent passivation treatments can include treatments involving a chelating agent and a metal ion or a chelated metal complex, as described in more detail below.

[0032] An ink can be printed on the chamfered edge to form an ink layer. The printing process can include a variety of types of printing, including inkjet printing, gravure printing, screen printing, or other types of printing. In a particular example, the ink layer can be formed using inkjet printing. The ink layer can include transparent, semi-transparent, and opaque inks of any desired color as described in more detail below. In certain examples, multiple different colors of ink can be printed on multiple different chamfered edges of the cover.

[0033] FIG. 5 is a flowchart illustrating an example method 500 of making a cover for an electronic device. The method includes forming 510 a metal cover substrate, and applying 520 a protective coating over a surface of the metal cover substrate. The method further includes chamfering 530 an edge of the metal cover substrate to form a chamfered edge that cuts through the protective coating and forms and exposed metal edge. In further detail, the method can include treating 540 the chamfered edge with a transparent passivation treatment to form a transparent passivation layer at exposed metal at the chamfered edge, and printing 550 an ink over the chamfered edge which includes the transparent passivation layer.

[0034] FIGS. 6A-6E show cross-sectional views illustrating another example method of making a cover for an electronic device. In FIG. 6A, a metal cover substrate 610 is formed. In FIG. 6B, the metal cover substrate is coated with a protective coating 620. In FIG. 6C, two edges of the cover are chamfered to form chamfered edges 630, 632. The chamfers cut through the protective coating and expose the metal cover substrate. After chamfering the edges, passivation layers 640, 642 are formed at the exposed metal cover substrate as shown in

FIG. 6D. Finally, FIG. 6E shows ink layers 650, 652 printed over the chamfered edges.

Metal Cover Substrate

5 [0035] The metal cover substrate can be made from a single metal, a metallic alloy, a combination of sections made from multiple metals, or a combination of metal and other materials. In some examples, the metal cover substrate can include a light metal. In certain examples, the metal cover substrate can include aluminum, magnesium, lithium, titanium, zinc, niobium, stainless
10 steel, or an alloy thereof. In further particular examples, the metal cover substrate can include aluminum, an aluminum alloy, magnesium, or a magnesium alloy. Non-limiting examples of elements that can be included in aluminum or magnesium alloys can include aluminum, magnesium, titanium, lithium, niobium, zinc, bismuth, copper, cadmium, iron, thorium, strontium, zirconium, manganese,
15 nickel, lead, silver, chromium, silicon, tin, gadolinium, yttrium, calcium, antimony, cerium, lanthanum, or others.

 [0036] In some examples, the metal cover substrate can include an aluminum magnesium alloys made up of about 0.5% to about 13% magnesium by weight and 87% to 99.5% aluminum by weight. Examples of specific aluminum
20 magnesium alloys can include 1050, 1060, 1199, 2014, 2024, 2219, 3004, 4041, 5005, 5010, 5019, 5024, 5026, 5050, 5052, 5056, 5059, 5083, 5086, 5154, 5182, 5252, 5254, 5356, 5454, 5456, 5457, 5557, 5652, 5657, 5754, 6005, 6005A, 6060, 6061, 6063, 6066, 6070, 6082, 6105, 6162, 6262, 6351, 6463, 7005, 7022, 7068, 7072, 7075, 7079, 7116, 7129, and 7178.

25 [0037] In further examples, the metal cover substrate can include magnesium metal, a magnesium alloy that is 99% or more magnesium by weight, or a magnesium alloy that is from about 50% to about 99% magnesium by weight. In a particular example, the metal cover substrate can include an alloy including magnesium and aluminum. Examples of magnesium-aluminum alloys can
30 include alloys made up of from about 91% to about 99% magnesium by weight and from about 1% to about 9% aluminum by weight, and alloys made up of about 0.5% to about 13% magnesium by weight and 87% to 99.5% aluminum by weight.

Specific examples of magnesium-aluminum alloys can include AZ63, AZ81, AZ91, AM50, AM60, AZ31, AZ61, AZ80, AE44, AJ62A, ALZ391, AMCa602, LZ91, and Magnox.

[0038] The metal cover substrate can be shaped to fit any type of electronic device, including the specific types of electronic devices described herein. In some examples, the metal cover substrate can have any thickness suitable for a particular type of electronic device. The thickness of the metal in the metal cover substrate can be selected to provide a desired level of strength and weight for the cover of the electronic device. In some examples, the metal cover substrate can have a thickness from about 0.5 mm to about 2 cm, from about 1 mm to about 1.5 cm, from about 1.5 mm to about 1.5 cm, from about 2 mm to about 1 cm, from about 3 mm to about 1 cm, from about 4 mm to about 1 cm, or from about 1 mm to about 5 mm, though thicknesses outside of these ranges can be used.

[0039] In still further examples, the metal cover substrate can include a metal having a micro-arc oxidation layer on a surface thereof. Micro-arc oxidation, also known as plasma electrolytic oxidation, is an electrochemical process where the surface of a metal is oxidized using micro-discharges of compounds on the surface of the substrate when immersed in a chemical or electrolytic bath, for example. The electrolytic bath may include predominantly water with about 1 wt% to about 5 wt% electrolytic compound(s), e.g., alkali metal silicates, alkali metal hydroxide, alkali metal fluorides, alkali metal phosphates, alkali metal aluminates, the like, and combinations thereof. The electrolytic compounds may likewise be included at from about 1.5 wt% to about 3.5 wt%, or from about 2 wt% to about 3 wt%, though these ranges are not considered limiting. In one example, a high-voltage alternating current can be applied to the substrate to create plasma on the surface of the substrate. In this process, the substrate can act as one electrode immersed in the electrolyte solution, and the counter electrode can be any other electrode that is also in contact with the electrolyte. In some examples, the counter electrode can be an inert metal such as stainless steel. In certain examples, the bath holding the electrolyte solution can be conductive and the bath itself can be used as the counter electrode. A high direct current or

alternating voltage can be applied to the substrate and the counter electrode. In some examples, the voltage can be about 200 V or higher, such as about 200 V to about 600 V, about 250 V to about 600 V, about 250 V to about 500 V, or about 200 V to about 300 V. Temperatures can be from about 20 °C to about 40 °C, or
5 from about 25 °C to about 35 °C, for example, though temperatures outside of these ranges can be used. This process can oxidize the surface to form an oxide layer from the substrate material. Various metal or metal alloy substrates can be used, including aluminium, titanium, lithium, magnesium, and/or alloys thereof, for example. The oxidation can extend below the surface to form thick layers, as
10 thick as 30 µm or more. In some examples the oxide layer can have a thickness from about 1 µm to about 25 µm, from about 1 µm to about 22 µm, or from about 2 µm to about 20 µm. Thickness can likewise be from about 2 µm to about 15 µm, from about 3 µm to about 10 µm, or from about 4 µm to about 7 µm. The oxide layer can, in some instances, enhance the mechanical, wear, thermal, dielectric,
15 and corrosion properties of the substrate. The electrolyte solution can include a variety of electrolytes, such as a solution of potassium hydroxide. In some examples, the metal cover substrate can include a micro-arc oxidation layer on one side, or on both sides.

20 *Protective Coatings*

[0040] In some examples, a protective coating layer can be applied over the metal cover substrate. In a certain example, the protective coating layer can include a polymer resin. In certain examples, the polymer resin can be transparent and the protective coating layer can be a clear coat layer that allows
25 the color of the underlying materials to show through. In further examples, the protective coating may be colored. In a particular example, the protective coating can include a layer of colored coating and a layer of clear coating on the colored coating. In some examples, the polymer resin of the clear coat layer can be clear poly(meth)acrylic, clear polyurethane, clear urethane (meth)acrylate, clear
30 (meth)acrylic (meth)acrylate, or clear epoxy (meth)acrylate coating.

[0041] In further examples, the protective coating can include fillers such as pigment dispersed in an organic polymer resin. Non-limiting examples of

pigments used in the protective coating layer can include carbon black, titanium dioxide, clay, mica, talc, barium sulfate, calcium carbonate, synthetic pigment, metallic powder, aluminum oxide, graphene, pearl pigment, or a combination thereof. The pigment can be present in the protective coating layer in an amount
5 from about 0.5 wt% to about 30 wt% with respect to dry components of the protective coating layer, in some examples. In other examples, the amount of pigment can be from about 1 wt% to about 25 wt% or from about 2 wt% to about 15 wt% with respect to dry components of the protective coating layer.

[0042] The polymer resin included in the protective coating layer with the
10 pigment can include polyester, poly(meth)acrylic, polyurethane, epoxy, urethane (meth)acrylic, (meth)acrylic (meth)acrylate, epoxy (meth)acrylate, or a combination thereof. As used herein, a "combination" of multiple different polymers can refer to a blend of homopolymers, a copolymer made up of the different polymers or monomers thereof, or adjacent layers of the different
15 polymers. In certain examples, the polymer resin of the protective coating layer can have a weight-average molecular weight from about 100 g/mol to about 6,000 g/mol.

[0043] The thickness of the protective coating layer can be from about 5 μm to about 100 μm in some examples. In further examples, the thickness can be
20 from about 10 μm to about 25 μm .

[0044] In certain examples, the protective coating layer can include a base coat that is colored and a top coat that is clear. Thus, the colored layer and the clear coat layer described above can be used together in certain examples. The overall thickness of the base coat with the top coat can be from about 2 μm to
25 about 100 μm , from about 5 μm to about 60 μm , or from about 10 μm to about 40 μm , in some examples.

[0045] In further examples, the colored protective coating layer, the top clear coat layer, or both, can be radiation curable. The polymer resin used in these layers can be curable using heat and/or radiation. For example, a heat
30 curing polymer resin can be used and then cured in an oven for a sufficient curing time. A radiation curing polymer resin can be exposed to sufficient radiation energy to cure the polymer resin. The protective coating layer can be cured after

applying the layer to the cover. In certain examples, curing can include heating the protective coating layer at a temperature from about 50 °C to about 80°C or from about 50 °C to about 60 °C or from about 60 °C to about 80 °C. The layer can be heated for a curing time from about 5 minutes to about 40 minutes, or from
5 about 5 minutes to about 10 minutes, or from about 20 minutes to about 40 minutes. In other examples, curing can include exposing the layer to radiation energy at an intensity from about 500 mJ/cm² to about 2,000 mJ/cm² or from about 700 mJ/cm² to about 1,300 mJ/cm². The layer can be exposed to the radiation energy for a curing time from about 5 seconds to about 30 seconds, or
10 from about 10 seconds to about 30 seconds.

[0046] In other examples the protective coating can be an electrophoretic coating. The electrophoretic coating can include a polymeric binder, a pigment, and a dispersant. The electrophoretic coating process can sometimes be referred to as “electropainting” or “electrocoating” because of the use of electric current in
15 the process. To deposit an electrophoretic coating on the cover of the electronic device, the metal cover substrate can be placed in a coating bath. The coating bath can include a suspension of particles including the polymeric binder, pigment, and dispersant. In certain examples, the solids content of the coating bath can be from about 3 wt% to about 30 wt% or from about 5 wt% to about 15
20 wt%. The metal cover substrate can be electrically connected to an electric power source. The metal cover substrate can act as one electrode and the power source can also be attached to a second electrode that is also in contact with the coating bath. An electric current can be run between the metal cover substrate and the second electrode. In certain examples, the electric current can be applied at a
25 voltage from about 30 V to about 150 V. The electric current can cause the particles suspended in the coating bath to migrate to the surface of the metal cover substrate and coat the surface. After this deposition process, additional processing may be performed such as rinsing the metal cover substrate, baking the coated substrate to harden the coating, or exposing the coated substrate to
30 radiation to cure radiation curable polymeric binders.

[0047] In some examples, electrophoretic coatings can include the same pigments and polymeric binders or resins described above in the paint-type

protective coating. The thickness of the coating can also be in the same ranges described above.

Transparent Passivation Layers

5 [0048] In further examples, a passivation treatment can be used to form a transparent passivation layer at the metal cover substrate exposed at the chamfered edge. It is noted that the transparent passivation layer is described as a layer for convenience, and thus, can be in the form of a layer. However, the term “passivation layer” also includes metal surface treatment of the exposed metal
10 substrate. In some sense, it may not be a discrete layer that is applied similarly to that of a coating or a paint, for example, but can become infused or otherwise become part of the metal substrate at or near a surface of the chamfered edge. In some examples, the transparent passivation layer can include a chelating agent and a metal ion or a chelated metal complex thereof, wherein the metal ion is an
15 aluminum ion, an indium ion, a nickel ion, a chromium ion, a tin ion, or a zinc ion. In certain examples, passivation treatment can be applied at a pH from about 2 to about 5. In a particular example, the pH can be about 2.5 to about 3.5. In further examples, the transparent passivation layer can include an oxide of one of these metals. In some cases, various contaminants can be present on the surface of the
20 metal cover substrate. The chelating agent can chelate such contaminants and prevent the contaminants from attaching to the surface of the metal cover substrate. Non-limiting examples of chelating agents can include ethylenediaminetetraacetic acid, ethylenediamine, nitrilotriacetic acid, diethylenetriaminepenta(methylenephosphonic acid),
25 nitrilotris(methylenephosphonic acid) and 1-hydroxyethane-1,1-disphosphonic acid. At the same time, a passivating metal oxide layer may form on the surface of the metal cover substrate. In some examples, the transparent passivation layer can have a thickness from about 10 nm to about 3 μm . In certain examples, the transparent passivation can be added to the pre-existing surface of the metal
30 cover substrate, such that the transparent passivation layer includes additional material added onto the surface of the metal cover substrate. In other examples, the passivation layer can involve converting the existing surface of the metal

cover substrate into a passive layer so that no net addition of material to the pre-existing surface occurs.

Ink Layers

5 [0049] In some examples, an ink layer can be printed on the chamfered edge of the cover for an electronic device. As used herein, "ink" refers to a fluid that can be printed by a printing process onto the surface and then dry or cure to form a solid layer. The printing process used to print the ink may be a digital printing process or an analog printing process. In certain examples, the ink can be
10 printed by inkjet printing, gravure printing, screen printing, or other printing processes.

[0050] In some examples, the ink layer can fully cover the sloped face created by the chamfer at the chamfered edge. In other examples, the ink layer can partially cover the sloped surface at the chamfered edge. In still other
15 examples, the ink layer can have a film thickness from about 1 μm to about 40 μm , from about 2 μm to about 30 μm , or from about 5 μm to about 20 μm .

[0051] Various inks can be used to form the ink layer, such as pigmented inks or dye-based inks. In some examples, the ink can include a colorant such as a pigment or dye, a binder, and a dispersant. These components can be
20 dispersed in a liquid vehicle such as water or an organic solvent. Non-limiting examples of the binder in the ink can include polyester acrylate copolymers, polyether polyol copolymers, polyester polyol copolymers, polyester urethane copolymers, polyurethane/ureas, polyesters, polyacrylates, polyurethanes, and others. Non-limiting examples of the dispersant can include sodium polyacrylate,
25 sodium polyoxyethylene alkyl ether carboxylate, sodium dodecyl sulfate, and others.

[0052] In some examples, the ink can be a transparent ink. With a transparent ink layer, the metallic luster of the metal cover substrate can be allowed to shine through the ink layer. In further examples, the ink can be
30 semi-transparent, which can partially allow the metallic luster of the metal cover substrate to show through. In still further examples, the ink can be an opaque ink to fully hide the surface of the metal cover substrate. In some examples, opaque

inks can include a concentration of color pigment greater than 0.1 wt%, such as 0.1 wt% to 15 wt% with respect to the total weight of the ink, for example.

Transparent or semi-transparent inks can in some examples have a concentration of color pigment less than about 0.1 wt% with respect to the total weight of the ink. Additionally, in some examples the ink can be thermal curing ink or radiation curing ink.

[0053] In a particular example, the ink can be printed by ink jet printing. As used herein, "ink jet" or "jet" refers to jetting architecture, such as ink jet architecture. Ink jet architecture can include thermal or piezo architecture.

Additionally, such architecture can be configured to print varying drop sizes such as less than about 10 picoliters, less than about 20 picoliters, less than about 30 picoliters, less than about 40 picoliters, less than about 50 picoliters, etc. In some examples, the ink for printing the ink layer can include a liquid vehicle appropriate for ink jet printing. The liquid vehicle can be an aqueous vehicle containing water.

In certain examples, water can be present in the ink in an amount of about 30 wt% or greater, about 40 wt% or greater, about 50 wt% or greater, or about 60 wt% or greater. In further examples, water can be present in an amount of at most about 99 wt% or at most about 95 wt%. In particular examples, water can be present in the ink in an amount of about 30 wt% to about 99 wt %, about 40 wt% to about 98 wt%, about 50 wt% to about 95 wt%, about 60 wt% to about 93 wt%, or about 70 wt% to about 90 wt%.

[0054] Co-solvents can also be included in the ink in some examples.

Non-limiting examples of co-solvents can include organic co-solvents, including alcohols (e.g., aliphatic alcohols, aromatic alcohols, polyhydric alcohols (e.g., diols), polyhydric alcohol derivatives, long chain alcohols, etc.), glycol ethers, polyglycol ethers, a nitrogen-containing solvent (e.g., pyrrolidinones, caprolactams, formamides, acetamides, etc.), and a sulfur-containing solvent.

Examples of such compounds include 1-aliphatic alcohols, secondary aliphatic alcohols, 1,2-alcohols, 1,3-alcohols, 1,5-alcohols, ethylene glycol alkyl ethers, propylene glycol alkyl ethers, higher homologs (C6-C12) of polyethylene glycol alkyl ethers, N-alkyl caprolactams, unsubstituted caprolactams, both substituted and unsubstituted formamides, both substituted and unsubstituted acetamides,

and the like. Still other examples of suitable co-solvents include propylene carbonate and ethylene carbonate.

[0055] A single co-solvent may be used, or several co-solvents may be used in combination. When included, the co-solvent(s) can be present in total in
5 an amount ranging from about 0.1 wt% to about 60 wt%, depending on the jetting architecture, though amounts outside of this range can also be used. In another example, the co-solvent(s) can be present in an amount from about 1 wt% to about 30 wt% or from about 1 wt% to about 20 wt% of the total weight of the ink.

[0056] In further examples, the ink can include additional ingredients, such
10 as additives to inhibit the growth of microorganisms, viscosity modifiers, material for pH adjustment, sequestering agents, anti-kogation agents, preservatives, and the like. Such additives may be present in an amount of about 0 to about 5 wt % of the ink.

[0057] The ink may also include surfactants in some examples. Suitable
15 surfactants may include non-ionic, cationic, and/or anionic surfactants. Examples include a silicone-free alkoxylated alcohol surfactant such as, for example, TEGO® Wet 510 (Evonik Tego Chemie GmbH, Germany) and/or a self-emulsifiable wetting agent based on acetylenic diol chemistry, such as, for example, SURFYNOL® SE-F (Air Products and Chemicals, Inc., Pennsylvania).
20 Other suitable commercially available surfactants include SURFYNOL® 465 (ethoxylated acetylenic diol), SURFYNOL® CT 211 (non-ionic, alkylphenylethoxylate and solvent free), and SURFYNOL® 104 (non-ionic wetting agent based on acetylenic diol chemistry), (all of which are from Air Products and Chemicals, Inc., Pennsylvania); ZONYL® FSO (a.k.a.
25 CAPSTONE®, which is a water-soluble, ethoxylated non-ionic fluorosurfactant from Dupont, Delaware); TERGITOL™ TMN-3 and TERGITOL™ TMN-6 (both of which are branched secondary alcohol ethoxylate, non-ionic surfactants), and TERGITOL™ 15-S-3, TERGITOL™ 15-S-5, and TERGITOL™ 15-S-7 (each of which is a secondary alcohol ethoxylate, non-ionic surfactant) (all of the
30 TERGITOL™ surfactants are available from The Dow Chemical Co., Michigan). Fluorosurfactants may also be employed. When present, the surfactant can be

present in the ink in an amount ranging from about 0.01 wt% to about 5 wt% based on the total wt% of the ink.

Definitions

5 [0058] It is noted that, as used in this specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the content clearly dictates otherwise.

[0059] The term "about" as used herein, when referring to a numerical value or range, allows for a degree of variability in the value or range, for
10 example, within 5% or other reasonable added range breadth of a stated value or of a stated limit of a range. The term "about" when modifying a numerical range is also understood to include the exact numerical value indicated, e.g., the range of about 1 wt% to about 5 wt% includes 1 wt% to 5 wt% as an explicitly supported sub-range.

15 [0060] As used herein, "liquid vehicle" or "ink vehicle" refers to a liquid fluid in an ink. A wide variety of ink vehicles may be used with the systems and methods of the present disclosure. Such ink vehicles may include a mixture of a variety of different agents, including, surfactants, solvents, co-solvents, anti-kogation agents, buffers, biocides, sequestering agents, viscosity modifiers,
20 surface- active agents, water, etc.

[0061] As used herein, "colorant" can include dyes and/or pigments.

[0062] As used herein, "dye" refers to compounds or molecules that absorb electromagnetic radiation or certain wavelengths thereof. Dyes can impart a visible color to an ink if the dyes absorb wavelengths in the visible spectrum.

25 [0063] As used herein, "pigment" generally includes pigment colorants, magnetic particles, aluminas, silicas, and/or other ceramics, organo-metallics or other opaque particles, whether or not such particulates impart color. Thus, though the present description primarily exemplifies the use of pigment colorants, the term "pigment" can be used more generally to describe pigment colorants and
30 other pigments such as organometallics, ferrites, ceramics, etc. In one specific example, however, the pigment is a pigment colorant

[0064] As used herein, a plurality of items, structural elements, compositional elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though the individual members of the list are individually identified as a separate and unique member.

5 Thus, no individual member of such list should be construed as a *de facto* equivalent of any other member of the same list solely based on their presentation in a common group without indications to the contrary.

[0065] Concentrations, dimensions, amounts, and other numerical data may be presented herein in a range format. It is to be understood that such range
10 format is used merely for convenience and brevity and should be interpreted flexibly to include the numerical values explicitly recited as the limits of the range, and also to include all the individual numerical values or sub-ranges encompassed within that range as if individual numerical values and sub-ranges are explicitly recited. For example, a layer thickness from about 0.1 μm to about
15 0.5 μm should be interpreted to include the explicitly recited limits of 0.1 μm to 0.5 μm , and to include thicknesses such as about 0.1 μm and about 0.5 μm , as well as subranges such as about 0.2 μm to about 0.4 μm , about 0.2 μm to about 0.5 μm , about 0.1 μm to about 0.4 μm etc.

[0066] The following illustrates an example of the present disclosure.
20 However, it is to be understood that the following is illustrative of the application of the principles of the present disclosure. Numerous modifications and alternative compositions, methods, and systems may be devised without departing from the spirit and scope of the present disclosure. The appended claims are intended to cover such modifications and arrangements.

25

Example

[0067] An example cover for an electronic device is made as follows:

1) A metal cover substrate is made by molding magnesium alloy. The metal cover substrate has the form of a laptop cover C, or the top
30 cover for the keyboard portion. The metal cover substrate includes an opening for a trackpad and a fingerprint scanner.

- 2) The metal cover substrate is painted by spraying a paint composition including a polymer binder and a black pigment to form a protective coating on the metal cover substrate.
- 3) A CNC milling machine is used to cut a first chamfer along the edges of the opening for the track pad. A second chamfer is cut along the edges of the opening for the fingerprint scanner. A third chamfer is cut along the rear edge of the metal cover substrate. The chamfers are cut at about a 45° angle and have a depth of about 2 mm.
- 4) The painted and chamfered metal cover substrate is placed in a passivation bath including ethylenediaminetetraacetic acid as a chelating agent and aluminum ions at a pH of 3.5 to form transparent passivation layers at the exposed metal at the chamfered edges.
- 5) An ink jet printer is used to print ink on the chamfered edges. The inkjet printer prints a transparent ink on the chamfered edge around the trackpad, a semi-transparent gold ink on the chamfered edge around the fingerprint scanner, and a red opaque ink on the chamfered edge at the rear of the cover.

CLAIMS

What is claimed is:

- 5 1. A cover for an electronic device comprising:
a metal cover substrate;
a protective coating on a surface of the metal cover substrate;
a chamfered edge including a chamfer at an edge of the metal cover
substrate, wherein the chamfer cuts through the protective coating to expose the
10 metal cover substrate at the chamfered edge;
a transparent passivation layer at the chamfered edge where the metal
cover substrate is exposed; and
an ink layer printed over the transparent passivation layer at the
chamfered edge.
- 15 2. The cover of claim 1, wherein the metal cover substrate comprises
aluminum, magnesium, lithium, titanium, zinc, niobium, stainless steel, or an alloy
thereof.
- 20 3. The cover of claim 2, wherein the metal cover substrate comprises a
micro-arc oxidation layer on a surface of the metal cover substrate, and wherein
the micro-arc oxidation layer is also chamfered.
4. The cover of claim 1, wherein the protective coating is a paint coating
25 comprising a colorant and a polymeric binder.
5. The cover of claim 1, wherein the protective coating is an electrophoretic
deposition coating comprising a polymer binder, a pigment, and a dispersant.
- 30 6. The cover of claim 1, wherein the transparent passivation layer
comprises a chelating agent and a metal ion, a chelated metal complex of the
chelating agent and the metal ion, an oxide of the metal ion, or a combination

thereof, wherein the metal ion is an aluminum ion, an indium ion, a nickel ion, a chromium ion, a tin ion, or a zinc ion.

7. The cover of claim 1, wherein the ink layer comprises a colorant and a
5 polymeric binder.

8. The cover of claim 1, further comprising a second chamfered edge and
a second ink layer printed over the second chamfered edge, wherein the ink layer
and the second ink layer are of a different color relative to one another.

10

9. An electronic device comprising:
an electronic component; and
a cover enclosing the electronic component, the cover comprising:
a metal cover substrate,
15 a protective coating on a surface of the metal cover substrate,
a chamfered edge including a chamfer at an edge of the metal
cover substrate, wherein the chamfer cuts through the
protective coating to expose the metal cover substrate at the
chamfered edge,
20 a transparent passivation layer at the chamfered edge where the
metal cover substrate is exposed, and
an ink layer printed over the transparent passivation layer at the
chamfered edge.

25 10. The electronic device of claim 9, wherein the electronic device is a
laptop, tablet computer, smartphone, an e-reader, or a music player.

11. The electronic device of claim 10, wherein the chamfered edge is
located at an edge of a touchpad, an edge of a fingerprint scanner, an outer edge
30 of the cover, an edge of a sidewall, or an edge of a logo.

12. The electronic device of claim 9, wherein the cover comprises multiple

chamfered edges with multiple ink layers at different chamfered edges having different colors printed at the multiple chamfered edges.

13. A method of making a cover for an electronic device comprising:
5 forming a metal cover substrate;
applying a protective coating over a surface of the metal cover substrate;
chamfering an edge of the metal cover substrate to form a chamfered edge
that cuts through the protective coating and forms an exposed metal edge;
treating the chamfered edge with a transparent passivation treatment to
10 form a transparent passivation layer at exposed metal at the chamfered edge;
and
printing an ink over the chamfered edge which includes the transparent
passivation layer.

15 14. The method of claim 13, wherein the ink is printed by an inkjet printer.

15 15. The method of claim 13, further comprising chamfering a second edge
of the metal cover substrate and printing a second ink over the second chamfered
edge, wherein the ink and the second ink have different colors.

1/6

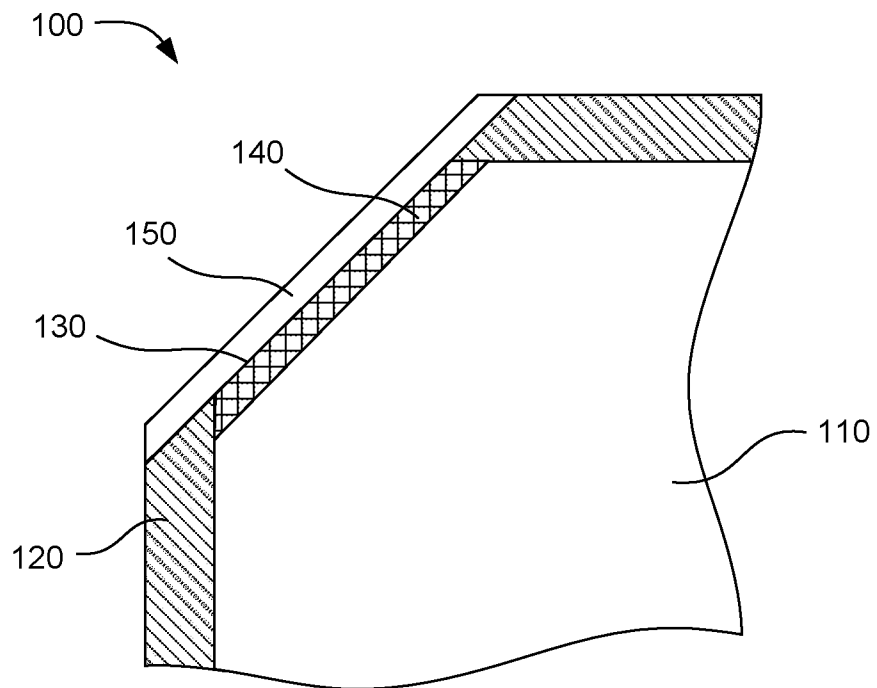


FIG. 1

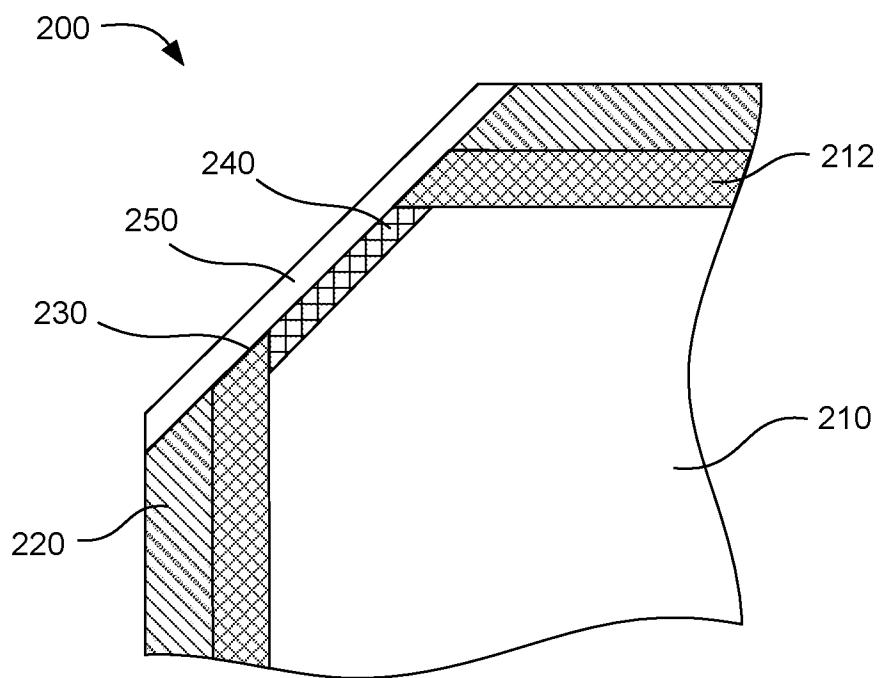


FIG. 2

2/6

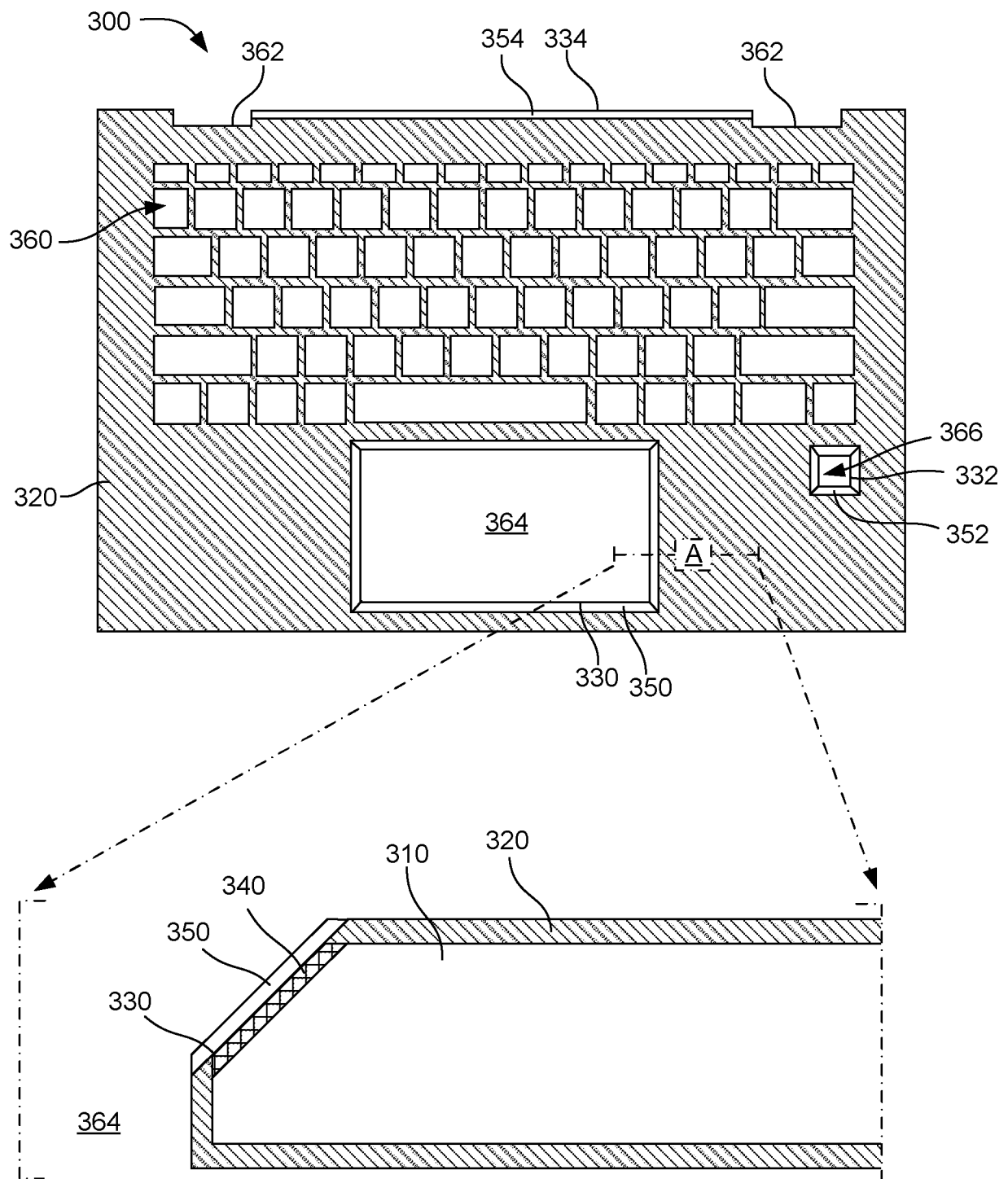


FIG. 3

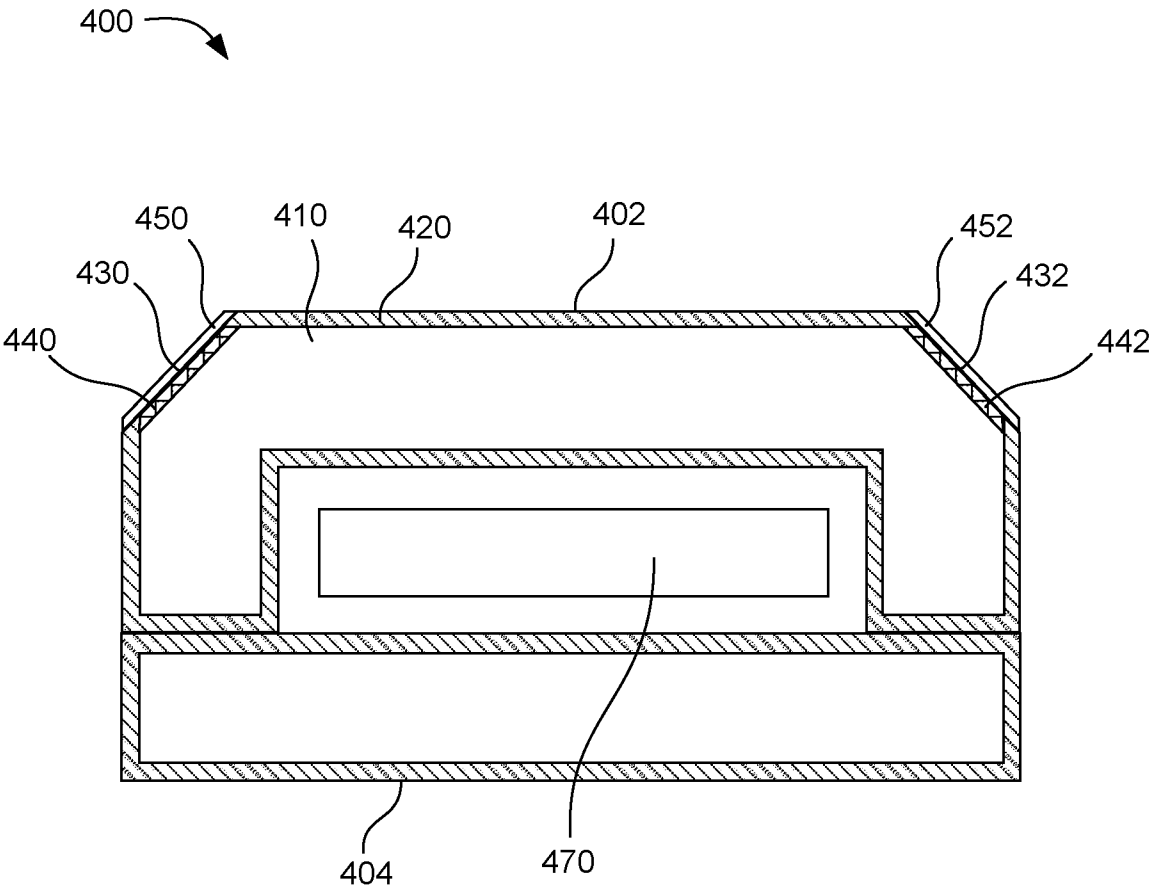


FIG. 4

4/6

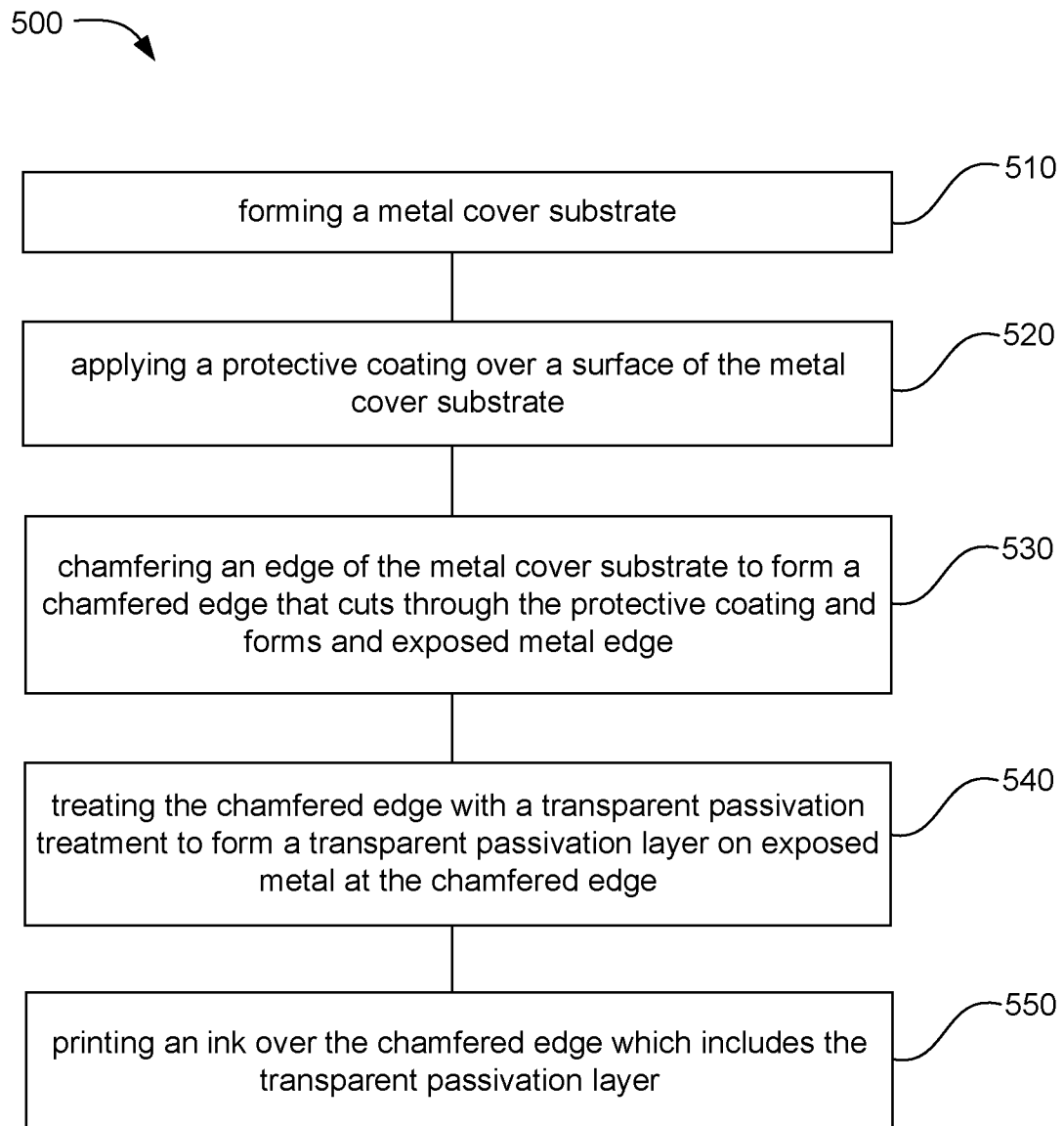


FIG. 5

5/6

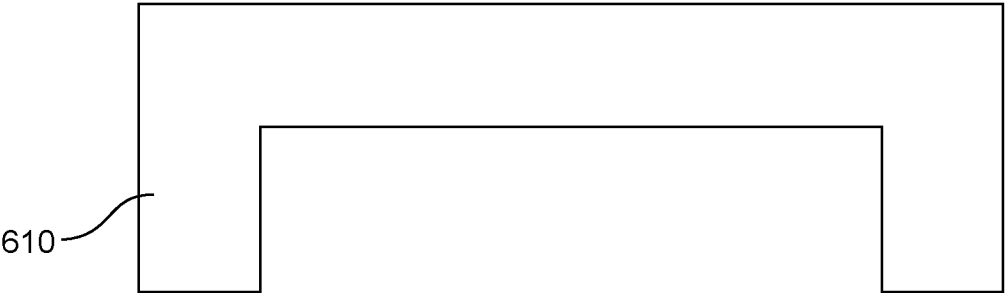


FIG. 6A

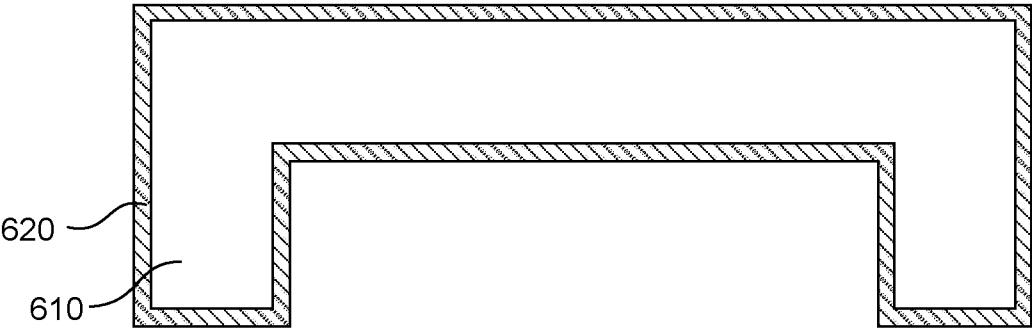


FIG. 6B

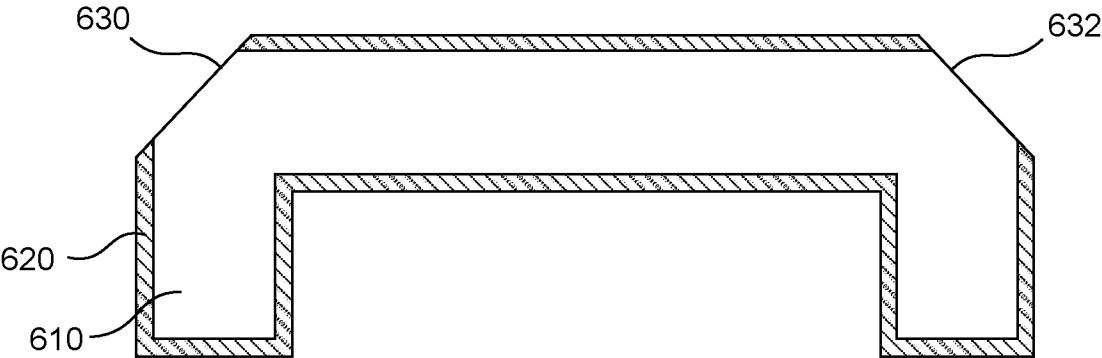


FIG. 6C

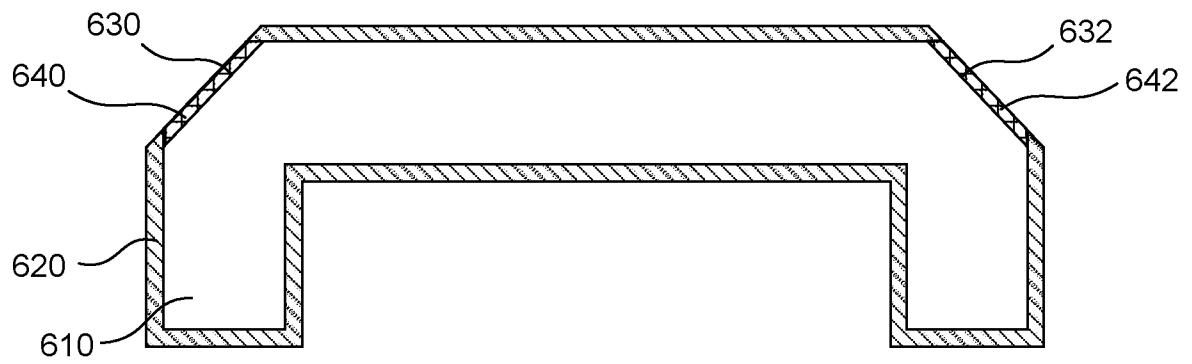


FIG. 6D

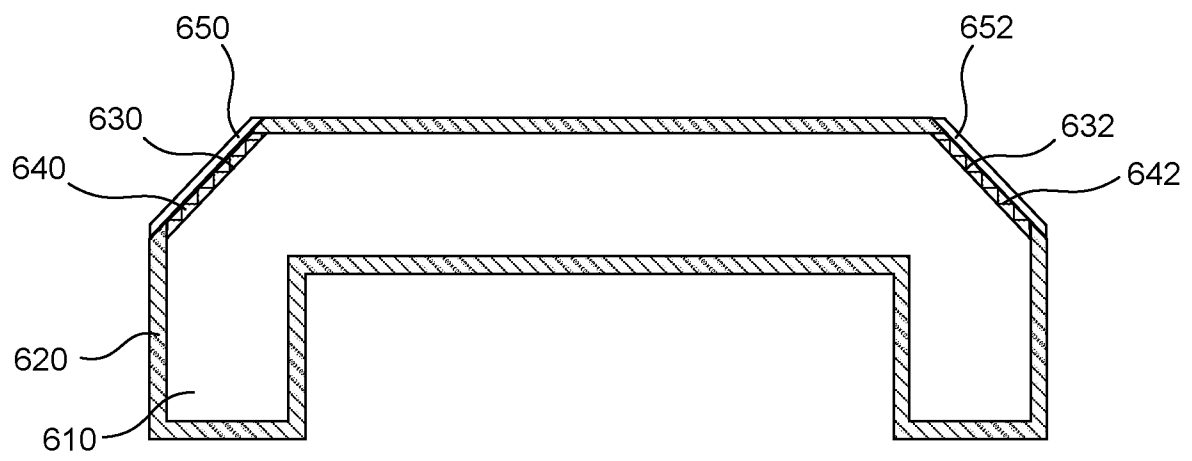


FIG. 6E

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2019/016258

A. CLASSIFICATION OF SUBJECT MATTER

*H05K 7/18 (2006.01)**C25D 13/06 (2006.01)*

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)

H03K 3/00-3/12; H05K 1/00-7/18; B41M 5/00-5/132, C25D 13/06

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)

PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2016/0119014 A1 (OTTER PRODUCTS, INC.) 28.04.2016, abstract, [0076], [0077], [0082], [0085], [0092], [0113], fig. 1, 23	1-15
Y	US 2014/0159064 A1 (LUXVUE TECHNOLOGY CORPORATION) 12.04.2007, abstract, [0009], [0150]	1-15
Y	CN 105154951 A (UNIV GUANGXI et al) 16.12.2015, abstract	3
Y	US 2010/0062264 A1 (BASF SE et al) 11.03.2010, abstract, [0012], [0034]	4, 7-8, 15
Y	CA 2478137 A1 (UNISEARCH LTD) 17.02.2006, abstract, claim 1	6



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier document but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

17 October 2019 (17.10.2019)

Date of mailing of the international search report

24 October 2019 (24.10.2019)

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