



(51) International Patent Classification:

G12B 9/02 (2006.01) C25D 13/20 (2006.01)

C23C 23/00 (2006.01) C25D 15/00 (2006.01)

C23C 22/00 (2006.01) C23F 17/00 (2006.01)

C25D 13/06 (2006.01) C23F 11/10 (2006.01)

(21) International Application Number:

PCT/US2019/012804

(22) International Filing Date:

09 January 2019 (09.01.2019)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, 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, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

Published:

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

(54) Title: HOUSINGS FOR ELECTRONIC DEVICES

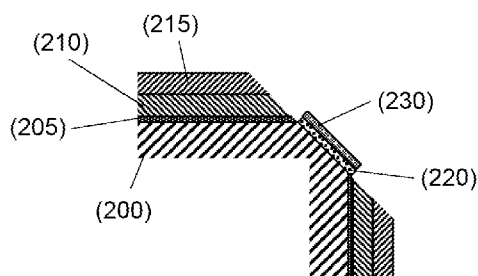


Figure 2

(57) Abstract: A housing for an electronic device is described. The housing comprises a substrate. The substrate comprises a magnesium alloy. An electrophoretic polymer layer overlies the substrate. A coating layer is positioned between the substrate and the electrophoretic polymer layer. The coating layer comprises (i) a layer comprising a chelating agent and a metal ion or chelated metal complex thereof, (ii) a passivation layer or (iii) a passivation layer and a layer comprising a chelating agent and a metal ion or chelated metal complex thereof. A method for manufacturing the housing is also described.

HOUSINGS FOR ELECTRONIC DEVICES

BACKGROUND

[0001] Electronic devices, such as laptops and mobile phones, include various components located within a housing. These devices are frequently subjected to mechanical deformation when they are placed in contact with other objects, such as a person's hand, a table or the ground. The housings that form the electronic devices should be able to tolerate such mechanical deformation and withstand wear and tear from regular use.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Figure 1 is a flow chart showing a method for manufacturing a housing for an electronic device.

[0003] Figures 2 to 4 each show, in an example, a partial cross-section through part of a housing for an electronic device.

[0004] Figure 5 is a flow chart showing an example of a method for manufacturing a housing for an electronic device of the present disclosure.

[0005] Figure 6 shows a housing for a laptop.

[0006] The figures depict several examples of the present disclosure. It should be understood that the present disclosure is not limited to the examples depicted in the figures

DETAILED DESCRIPTION

[0007] As used in the present disclosure, the term "about" is used to provide flexibility to an endpoint of a numerical range. The degree of flexibility of this term can be dictated by the particular variable and is determined based on the associated description herein.

[0008] Amounts and other numerical data may be expressed or presented herein in a range format. It is to be understood that such a range format is used merely for convenience and brevity and thus should be interpreted flexibly to include not just the numerical values explicitly recited as the limits of the range, but also to

include individual numerical values or sub-ranges encompassed within that range as if each numerical value and sub-range is explicitly recited.

[0009] As used in the present disclosure, the term “disposed” when used to refer to the location or position of a layer includes the term “deposited” or “coated”.

[0010] As used in the present disclosure, the term “comprises” has an open meaning, which allows other, unspecified features to be present. This term embraces, but is not limited to, the semi-closed term “consisting essentially of” and the closed term “consisting of”. Unless the context indicates otherwise, the term “comprises” may be replaced with either “consisting essentially of” or “consists of”.

[0011] 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 context clearly dictates otherwise.

[0012] The present disclosure refers herein to a housing for an electronic device, to a method of manufacturing a housing and to an electronic device.

[0013] The housing comprises a substrate. The substrate comprises a magnesium alloy. An electrophoretic polymer layer overlies the substrate. A coating layer is positioned between the substrate and the electrophoretic polymer layer. The coating layer is either (i) a layer comprising a chelating agent and a metal ion or chelated metal complex thereof, (ii) a passivation layer or (iii) a passivation layer and a layer comprising a chelating agent and a metal ion or chelated metal complex thereof.

[0014] The electronic device comprises an electrical circuit and the housing. The housing is external to the electrical circuit.

[0015] The method for manufacturing the housing for an electronic device involves coating a substrate with (i) a layer comprising a chelating agent and a metal ion or a chelated metal complex thereof, (ii) a passivation layer, or (iii) a passivation layer and a layer comprising a chelating agent and a metal ion or a chelated metal complex thereof, to form a coating layer. The substrate comprises a magnesium alloy. An electrophoretic polymer layer is applied over the coating layer.

[0016] It is to be understood that this disclosure is not limited to the housings, electronic devices or methods disclosed herein. It is also to be understood that the terminology used in this disclosure is used for describing particular examples.

Substrate

[0017] The substrate may comprise a metal selected from aluminum, magnesium, lithium, titanium, zinc and alloy thereof. These metals are light-weight and can provide a durable housing.

[0018] The substrate may be an insert molded metal substrate. For example, the insert molded metal substrate may be formed by insert molding the metal with a plastic, such as a plastic selected from polybutylene terephthalate (PBT), polyphenylene sulfide (PPS), polyamide (nylon), polyphthalamide (PPA), acrylonitrile butadiene styrene (ABS), polyetheretherketone (PEEK), polycarbonate (PC), and ABS/PC with 15- 50% glass fiber filler.

[0019] In an example, the substrate comprises a magnesium alloy. When the substrate is made of a magnesium alloy, then the housing is mechanically durable, is light-weight and can provide an exterior metallic appearance. Magnesium alloys have a specific gravity that is about 70% that of aluminum, a high specific strength, and excellent heat removal characteristics. Electronic devices having a lighter and thinner housing can be manufactured when the substrate is made from a magnesium alloy.

[0020] Generally, the magnesium alloy comprises a content of magnesium of at least about 75 wt.%. For example, the magnesium alloy may comprise at least about 80 wt.% or at least about 90 wt.% of magnesium.

[0021] The magnesium alloy may further comprise aluminum, zinc, manganese, silicon, copper, a rare earth metal or zirconium. The aluminum content may be about 2.5 wt.% to about 13.0 wt.%. When the magnesium alloy comprises aluminum, then at least one of manganese, zirconium or silicon is also present. Examples of magnesium alloys include AZ31, AZ31B, AZ61, AZ60, AZ80, AM60, AZ91, AZ91D, LZ91, LZ14 and ALZ alloys, according to the American Society for Testing and Materials standards.

[0022] The substrate may have a first coated surface and a second coated surface. The first coated surface is different to the second coated surface.

[0023] When the substrate has a first coated surface and a second coated surface, then the second coated surface comprises the electrophoretic polymer layer and the coating layer is either a (i) layer comprising a chelating agent and a metal ion or chelated metal complex thereof, (ii) a passivation layer or (iii) a passivation layer and a layer comprising a chelating agent and a metal ion or chelated metal complex thereof.

Coating layer

[0024] The coating layer may be transparent.

[0025] The coating layer is positioned between the substrate and the electrophoretic polymer layer. The coating layer is disposed on a surface of the substrate. Thus, the coating layer is in contact with the surface of the substrate.

[0026] The coating layer is either a (i) layer comprising a chelating agent and a metal ion or chelated metal complex thereof, (ii) a passivation layer or (iii) a passivation layer and a layer comprising a chelating agent and a metal ion or chelated metal complex thereof.

[0027] The coating layer may be a layer comprising a chelating agent and a metal ion or a chelated metal complex thereof, or a mixture of the chelating agent, the metal ion and the chelated metal complex. The chelated metal complex comprises a ligand coordinated to the metal ion. The ligand is the chelating agent.

[0028] The chelating agent may be selected from ethylenediaminetetraacetic acid (EDTA), ethylenediamine (EN), nitrilotriacetic acid (NTA), diethylenetriamine-penta(methylenephosphonic acid) (DTPPH), nitrilotris(methylenephosphonic acid) (NTMP) and 1-hydroxyethane-1,1-disphosphonic acid (HEDP). In one example, the chelating agent is DTPPH.

[0029] The metal ion is selected from an aluminum ion, a nickel ion, a chromium ion, a tin ion, an indium ion and a zinc ion. In one example, the metal ion is selected from an aluminum ion, a nickel ion and a zinc ion.

[0030] In one example, the chelated metal complex may comprise DTPPH chelated to an aluminum ion. In another example, the chelated metal complex

may comprise DTPPH chelated to a nickel ion. In a further example, the chelated metal complex may comprise DTPPH chelated to a zinc ion.

[0031] The coating layer comprising the chelating agent and the metal ion or the chelated metal complex may have a thickness of about 30 nm to about 1 μm , such as from about 200 nm to about 750 nm.

[0032] The coating layer provides a thin, protective layer for the surface of the substrate, particularly when disposed on an exposed surface of the substrate. When the coating layer comprises the chelating agent and the metal ion or the chelated metal complex, the resulting layer may passivate an exposed surface of the substrate and can prevent it from losing its shiny appearance.

[0033] The coating layer may be a passivation layer. The passivation layer may comprise a salt selected from a molybdate salt, a vanadate salt, a phosphate salt, a chromate salt, a stannate salt and a manganese salt. In one example, the passivation layer comprises a phosphate salt.

[0034] The passivation layer may be transparent.

[0035] The passivation layer can have a thickness of from about 0.5 to about 5 μm .

[0036] The coating layer may be a passivation layer, such as described above, and a layer comprising a chelating agent and a metal ion or a chelated metal complex thereof, such as described above. In one arrangement, the passivation layer may be disposed on a surface of the substrate, and the layer comprising a chelating agent and a metal ion or a chelated metal complex thereof may be disposed on the passivation layer. In another arrangement, the layer comprising a chelating agent and a metal ion or a chelated metal complex thereof may be disposed on a surface of the substrate, and the passivation layer may be disposed on the layer comprising a chelating agent and a metal ion or a chelated metal complex thereof.

[0037] In one example, the coating layer is disposed on a non-oxidized surface of the substrate. The non-oxidized surface of the substrate may be referred to herein as the "second surface" of the substrate. The coating layer may form part of a "second coated surface" of the substrate. The second coated surface may

comprise the coating layer coated directly on to a surface of the substrate, which is the non-oxidized surface of the substrate.

[0038] The second surface may be obtained by cutting a first coated surface of the substrate using, for example, laser etching or engraving, or a computer numeric control (CNC) process, to expose a non-oxidized surface of the substrate.

[0039] The non-oxidized surface of the substrate is an uncoated surface of the substrate that has not undergone substantial oxidation, so that, for example, it retains its metallic appearance. The non-oxidized surface of the substrate does not include a surface of the substrate coated with a non-oxidized layer, such as a coating described below that may form part of the first coated surface.

[0040] By coating the non-oxidized surface of the substrate with the coating layer it is possible to both protect and retain the attractive, shiny appearance of the underlying metallic substrate. The coating layer of the second coated surface can provide a glossy or metallic lustre feeling, such as when used with a magnesium alloy substrate. Unlike coatings formed by electroplating processes, the layer can protect the exposed, underlying surface from corrosion. The second coated surface can show good resistance as tested using a salt fog test, such as ASTM B117, particularly when compared to coatings formed by electroplating.

Electrophoretic polymer layer

[0041] The electrophoretic polymer layer overlies the coating layer. Thus, the electrophoretic polymer layer is disposed on the coating layer. The electrophoretic polymer layer can protect the coating layer, and may ensure that both the attractive, shiny appearance of the underlying metallic substrate and the metallic lustre feeling are retained.

[0042] The electrophoretic polymer layer may comprise a polymer selected from an epoxy polymer, polyvinylpyrrolidone, polyethyleneimine, and a polyacrylic polymer. In one example, the polymer is a polyacrylic polymer.

[0043] The electrophoretic polymer layer may be transparent.

[0044] In one example, the electrophoretic polymer layer is colorless. In another example, the electrophoretic polymer layer may be colored.

[0045] The electrophoretic polymer layer may further comprise a pigment. Pigment particles may be dispersed throughout the electrophoretic polymer layer.

[0046] The pigment may be selected from carbon black, titanium dioxide, clay, mica, talc, barium sulfate, calcium carbonate, synthetic pigment, pearl pigment, metallic powder, aluminum oxide, dye, graphene, graphite, and an inorganic powder. In one example, the pigment is a dye. The dye may be dispersed throughout the electrophoretic polymer layer.

[0047] The electrophoretic polymer layer may have a thickness of about 5 to about 60 μm .

[0048] The electrophoretic polymer layer may form part of the second coated surface.

[0049] In general, the second coated surface may comprise the coating layer disposed on a non-oxidized surface of the substrate, and the electrophoretic polymer layer disposed on the coating layer.

First coated surface

[0050] The substrate may have a first coated surface where a first surface of the substrate is coated with at least one layer. The first coated surface may comprise an oxidized layer or a protective layer. When, for example, a magnesium alloy surface is exposed to air, it rapidly oxidizes and forms a dull surface that has an unattractive appearance. By applying a coating to a surface of the substrate, the underlying metallic substrate can be protected. Layers can also be applied to give the surface an attractive appearance.

[0051] When the first coated surface comprises an oxidized layer, this layer may comprise a passivation layer, an oxidized layer of the metallic substrate or both an oxidized layer of the metallic substrate and a passivation layer. The passivation layer may also be referred to herein as an inorganic layer.

[0052] The passivation layer may comprise a salt selected from a molybdate salt, a vanadate salt, a phosphate salt, a chromate salt, a stannate salt and a manganese salt. In one example, the passivation layer comprises a phosphate salt. The passivation layer contains oxidic salts that can provide the first surface with a dark grey appearance.

[0053] In one example, when the substrate comprises a magnesium alloy, the oxidized layer of the metallic substrate is an oxidized layer of the magnesium alloy.

[0054] The oxidized layer of the metallic substrate may be a micro-arc oxide layer, such as a micro-arc oxide layer of the magnesium alloy. The micro-arc oxide layer may be obtainable from the method described herein.

[0055] The oxidized layer of the metallic substrate, including the micro-arc oxide layer, can have a thickness of from about 3 to about 15 μm . The passivation layer can have a thickness of from about 0.5 to about 5 μm .

[0056] Both an oxidized layer of the metallic substrate and a passivation layer may be present. In one example, the passivation layer can be deposited or coated on the surface of the magnesium alloy.

[0057] In another example, the oxidized layer or the inorganic layer can be a single layer, which is a micro-arc oxide layer or a passivation layer. By itself, the micro-arc oxide layer or the passivation layer can prevent corrosion of the magnesium alloy.

[0058] The first coated surface may comprise at least one protective layer, such as two, three or four protective layers. Each protective layer may be selected from a base coating layer, a primer coating layer, a powder coating layer and a top coating layer. Each of these protective layers may be made of different material and may provide different functionality, such as heat resistance, hydrophobicity, and anti-bacterial properties.

[0059] The protective layer may be deposited or coated directly on to the first surface of the substrate. This means that there is no intervening oxidized layer between the protective layer and the first surface of the substrate.

[0060] The base coating layer may comprise a component selected from barium sulfate, talc, a dye and a color pigment. In one example, the base coating layer comprises a color pigment or a dye.

[0061] The base coating layer may further comprise a heat resistant material, such as a silica aerogel. The base coating layer can comprise a heat resistant material and a component as described above.

[0062] The base coating layer can have a thickness of from about 10 μm to about 25 μm , such as about 15 to about 20 μm .

[0063] In an example, the base coating layer comprises polyurethane-containing pigments. The base coating layer may further comprise at least one of carbon black, titanium dioxide, clay, mica, talc, barium sulfate, calcium carbonate, synthetic pigment, metallic powder, aluminum oxide, an organic powder, graphene, graphite, plastic beads, a color pigment or a dye. The organic powder may, for example, be an acrylic, a polyurethane, a polyamide, a polyester or an epoxide.

[0064] By using a base coating layer, other different protective layers can easily be deposited on the first surface, such as when the first surface has been coated with an oxide layer, and it may improve adhesion between different protective layers.

[0065] The primer coating layer may comprise a polyurethane or a filler selected from carbon black, titanium dioxide, clay, mica, talc, barium sulfate, calcium carbonate, a synthetic pigment, a metallic powder, aluminum oxide, carbon nanotubes (CNTs), graphene, graphite, and an organic powder. The organic powder may, for example, be an acrylic, a polyurethane, a polyamide, a polyester or an epoxide. The primer coating layer may, for example, comprise a polyurethane and a filler as described above.

[0066] A heat resistant material may be included in the primer coating layer. In an example, the primer coating layer contains a heat resistant material, a filler as described above and optionally a polyurethane.

[0067] The primer coating layer can have a thickness of from about 5 μm to about 20 μm .

[0068] The powder coating layer may comprise a polymer selected from an epoxy resin, a poly(vinyl chloride), a polyamide, a polyester, a polyurethane, an acrylic and a polyphenylene ether.

[0069] In an example, the powder coating layer is an electrostatic powder coating layer. The powder coating layer may be electrostatically deposited or coated onto a first surface of the substrate and then the polymer may be cured.

[0070] The powder coating layer may further comprise a filler selected from carbon black, titanium dioxide, clay, mica, talc, barium sulfate, calcium carbonate, a synthetic pigment, a metallic powder, aluminum oxide, carbon nanotubes

(CNTs), graphene, graphite, and an organic powder. The organic powder may, for example, be an acrylic, a polyurethane, a polyamide, a polyester or an epoxide.

[0071] A heat resistant material may be included in the powder coating layer. In an example, the powder coating layer comprises a polymer, a filler and a heat resistant material.

[0072] The powder coating layer can have a thickness of from about 20 μm to about 60 μm , such as about 30 μm to about 50 μm .

[0073] The top coating layer comprises a polymer selected from a polyurethane, a polycarbonate, a urethane acrylate, a polyacrylate, a polystyrene, a polyetheretherketone, a polyester, a fluoropolymer and a mixture thereof.

Examples of fluoropolymers include fluoroacrylates, fluorosiliconeacrylates, fluorourethanes, perfluoropolyethers, perfluoropolyoxetanes, fluorotelomers, polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVDF), fluorosiloxane, fluoroUV polymers and hydrophobic polymers.

[0074] The top coating layer may be transparent.

[0075] The top coating layer may have hydrophobic, anti-bacterial, anti-smudge, and anti-fingerprint properties. By using an anti-smudging top coating layer, the surface of the housing may be smudge free.

[0076] The top coating layer can have a total thickness of from about 10 μm to about 25 μm , such as about 15 μm to about 20 μm .

[0077] The top coating layer may comprise a bottom layer and a top layer coated or deposited on the bottom layer. The bottom layer may comprise a polyurethane polymer. The top layer may comprise a UV top coat. The UV top may, for example, be a resin, such as a polyacrylic resin, a polyurethane resin, a urethane acrylate resin, an acrylic acrylate resin or an epoxy acrylate resin.

[0078] When the top coating layer comprises a bottom layer and a top layer, then both the bottom layer and the top layer may be transparent.

[0079] The first coated surface may comprise an oxidized layer and a protective layer. The protective layer may be disposed on the oxidized layer.

[0080] In one example, the first coated surface comprises a single layer, such as an oxidized layer or a protective layer. In general, the single layer may be a protective layer selected from the group consisting of selected from a base coating

layer, a primer coating layer, a powder coating layer and a top coating layer. The protective layer may be disposed directly on to the first surface of the substrate.

[0081] In another example, the first coated surface comprises a plurality of layers, such as two, three or four layers. In general, the topmost layer of the first coated surface is a top coating layer.

[0082] An oxidized layer or a protective layer, as described in the present disclosure, may be disposed directly on to the first surface of the substrate. The oxidized layer or the protective layer provides a first layer of the first coated surface. The first layer is on the first surface of the substrate.

[0083] When the first layer is a protective layer, then the protective layer may be a powder coating layer or a primer coating layer. In one example, the first layer is a powder coating layer.

[0084] The first coated surface may comprise a protective layer, as described in the present disclosure, disposed on the first layer. This protective layer may provide a second layer of the first coated surface. When the first layer is a protective layer, then the second layer is a different protective layer to the protective layer of the first layer. Thus, in one example, when the first layer is a powder coating layer, then either (a) the second layer is a different powder coating layer to the powder coating layer of the first layer or (b) the second layer is not a powder coating layer. In another example, when the first layer is a primer coating layer, then either (a) the second layer is a different primer coating layer to the primer coating layer of the first layer or (b) the second layer is not a primer coating layer.

[0085] The second layer of the first coated surface may be selected from a base coating layer, a primer coating layer, a powder coating layer and a top coating layer.

[0086] When the first layer is an oxidized layer or a powder coating layer, then the second layer may be a primer coating layer or a top coating layer. In one example, the second layer is a primer coating layer. In another example, the second layer is a top coating layer.

[0087] When the first layer is an oxidized layer or a primer coating layer, then the second layer may be a top coating layer or a base coating layer. In one example,

the second layer is a base coating layer. In another example, the second layer is a top coating layer.

[0088] The first coated surface may comprise a protective layer disposed on the second layer. This protective layer may provide a third layer of the first coated surface. The third layer is different to the second layer. When the second layer is a primer coating layer, then either (a) the third layer is a different primer coating layer to the primer coating layer of the second layer or (b) the third layer is not a primer coating layer. When the second layer is a base coating layer, then either (a) the third layer is a different base coating layer to the base coating layer of the second layer or (b) the third layer is not a base coating layer.

[0089] The third layer of the first coated surface may be selected from a base coating layer, a primer coating layer, a powder coating layer and a top coating layer. The third layer of the first coated surface may be a base coating layer or a top coating layer.

[0090] When the second layer is a based coating layer, then the third layer may be a top coating layer.

[0091] The presence of a first coated surface having multiple layers on the substrate allows the formation of patters on the layers through laser etching or a computer numeric control (CNC) process. A variety of patterned features can be readily formed, which can provide a distinct finish on the sidewalls or surfaces of the housing.

[0092] As will be explained below, the first coated surface is cut to expose a non-oxidized surface of the substrate. This process may remove part of the first coated surface that was previously applied.

Housing

[0093] Housings made from metallic substrates can be light-weight and durable, but can have poor color stability, hardness and chemical resistance. It is difficult to provide a metallic housing having an attractive surface finish and a pleasant tactile texture.

[0094] As described in the present disclosure, the housing is made from a metallic substrate. The metallic substrate can be light-weight and may provide a

durable housing. The housing of the present disclosure may have cosmetic features that are visually appealing to a user, such as an attractive surface finish, and it may have a design features with a pleasant texture.

[0095] The housing may be obtained from the method of the manufacturing of the present disclosure.

[0096] In the present disclosure, the housing may comprise a third coated surface. The third coated surface may be disposed on the first coated surface and/or the second coated surface. The third coated surface may provide the housing with additional protection.

[0097] In one example, the third coated surface is disposed or coated on the first coated surface and the second coated surface. The third coated surface may be a single coating that covers both the first and second coated surfaces.

[0098] In general, the third coated surface may comprise a top coating layer. The top coating layer, such as described for the first coated surface. The top coating layer may comprise a polymer selected from a polyurethane, a polycarbonate, a urethane acrylate, a polyacrylate, a polystyrene, a polyetheretherketone, a polyester, a polyester-polyether copolymer, a polyamide-polyether copolymer, nylon, a fluoropolymer and a mixture thereof. In one example, the top coating layer comprises a polyurethane polymer.

[0099] The top coating layer may be transparent. This is to allow the exposed surface of the substrate to be visible through the top coating layer.

[0100] The top coating layer may have hydrophobic, anti-bacterial, anti-smudge, and anti-fingerprint properties. By using an anti-smudging top coating layer, the surface of the housing may be smudge free.

[0101] The third coated surface may comprise two layers. The third coated surface may comprise a first coating layer and a second coating layer. The second coating layer may be disposed on the first coating layer. Both the first coating layer and the second coating layer may each be disposed or coated on the first coated surface and the second coated surface. Thus, the first coating layer may be a single coating that covers both the first and second coated surfaces. The second coating layer may be a single coating that covers the first coating layer.

[0102] The first coating layer and the second coating layer may each be transparent. The exposed surface of the substrate can then be seen through the first coating layer and the second coating layer.

[0103] In one example, the first coating layer may comprise a polymer. The polymer may be selected from a polyurethane, a polycarbonate, a urethane acrylate, a polyacrylate, a polystyrene, a polyetheretherketone, a polyester, a polyester-polyether copolymer, a polyamide-polyether copolymer, nylon, a fluoropolymer and a mixture thereof. The second coating layer may be a UV coating. The UV top may, for example, be a resin, such as a polyacrylic resin, a polyurethane resin, a urethane acrylate resin, an acrylic acrylate resin or an epoxy acrylate resin.

[0104] In another example, the first coating layer comprises a polyurethane polymer and the second coating layer is a UV coating.

[0105] The housing is for an electronic device having an electrical circuit. In the housing of the present disclosure, the first coated surface and the second coated surface of the housing may be external to the electrical circuit. When the housing has a third coated surface, then the third coated surface may be external to the electrical circuit.

[0106] The housing may provide an exterior part of the electronic device, such as a cover or a casing of the electronic device. The housing may include a support structure for an electronic component of the electronic device.

[0107] The housing may include a battery cover area, a battery door or a vent.

[0108] The housing may provide a substantial part of the cover or the casing of the electronic device. The term "substantial part" in this context refers to at least about 50 %, such as at least about 60 %, at least about 70 %, at least about 80 % or at least about 90 %, of the total weight of the cover or the casing. The housing may provide the entire cover or casing of the electronic device.

[0109] The housing can be a cover, such as a lid, the casing or both the cover and the casing of the electronic device. The casing may form a bottom or lower part of the cover of the electronic device. In one example, the housing is the casing of a laptop, a tablet or a cell phone.

[0110] The first coated surface of the housing may provide an exterior cover or an exterior casing of the electronic device. The first coated surface may provide a bezel for a display screen, or a casing and/or wrist rest for a keyboard.

[0111] The second coated surface of the housing may provide a surface that forms an edge or part of a peripheral area of a tactile device of the electronic device. The second coated surface may provide an edge or a peripheral area in the housing for a touchpad, a fingerprint scanner, a trackball, a pointing stick, or a button, such as a mouse button or a keyboard button.

[0112] An example of a housing of the present disclosure is shown in Figure 2, which is a partial cross section through the housing. The housing has a substrate 200 with an oxidized layer 205, which may be a passivation layer or a micro-arc oxide layer. A first protective layer 210 is disposed on the oxidized layer 205. The first protective layer 210 may, for example, be a primer coating layer. A second protective layer 215 is disposed on the first protective layer 210. The second protective coating layer 215 may be a top coating layer. The oxidized layer 205, the first protective layer 210 and the second protective layer 215 form the first coated surface of the substrate 200. A coating layer 220 is coated onto a non-oxidized surface of the substrate 200. The layer comprises a chelated metal complex. Coating layer 220 is transparent. An electrophoretic polymer layer 230 is disposed on coating layer 220. This layer 230 and the coating layer 220 form the second coated surface of substrate 200. The electrophoretic polymer layer 230 may be colored.

[0113] Figure 3 shows a partial cross section of another example of a housing of the present disclosure. As in Figure 2, the substrate 200 has an oxidized layer 205 and two protective layers 210 and 215. A third protective layer 225 is also present, which is disposed on the second protective layer 215. The oxidized layer 205 and the first to third protective layers 210, 215 and 225 form the first coated surface of the substrate 200. The oxidized layer 205 may be a passivation layer or a micro-arc oxide layer. The first protective layer 210 may, for example, be a primer coating layer. The second protective layer 215 may be a base coating layer. The third protective layer 225 may be a top coating layer.

[0114] A coating layer 220 comprising a chelated metal complex is coated onto a non-oxidized surface of the substrate 200. An electrophoretic polymer layer 230 is coated onto the coating layer 220. The combination of the coating layer 220 and the electrophoretic polymer layer 230 form the second coated surface of substrate 200. The electrophoretic polymer layer 230 may be colored.

[0115] Another example of a housing of the present disclosure is shown in Figure 4. This partial cross section shows a housing that is identical to the housing shown in Figure 3, except that layer 205 is a protective layer instead of an oxidized layer. Protective layer 205 is a powder coating layer.

[0116] Figure 5 shows an example of a housing of the present disclosure. The housing is a casing 300 for a keyboard of a laptop. The first coated surface 310 provides a wrist rest and cover for the laptop. The housing has two second coated surfaces 320 and 330. One of these surfaces 320 was diamond cut from the main casing and forms an edge around a touchpad. The other surface 330 was also diamond cut from the main casing and provides an edge around a fingerprint scanner. Both surfaces have an attractive appearance and provide a pleasant tactile surface.

Method of manufacture

[0117] The present disclosure also relates to a method for manufacturing a housing for an electronic device.

[0118] The substrate is coated with either (i) a layer comprising a chelating agent and a metal ion or a chelated metal complex thereof, (ii) a passivation layer or (iii) a passivation layer and a layer comprising a chelating agent and a metal ion or chelated metal complex thereof, to form a coating layer.

[0119] To coat (i) or the layer in (iii), a solution comprising the chelating agent and the metal ion, the chelated metal complex or a mixture thereof may be coated onto the substrate. The solution may be sprayed, rolled, dipped, or brushed onto the non-oxidized surface.

[0120] The coating layer comprising a chelating agent and a metal ion or a chelated metal complex thereof may be formed under acidic conditions, such as at a pH of from about 2 to about 6. Thus, the solution coated onto the substrate that

comprises the chelating agent and the metal ion, the chelated metal complex or a mixture thereof may have a pH of from about 2 to about 6.

[0121] To coat (ii) or the passivation layer in (iii), a solution comprising a salt selected from a molybdate salt, a vanadate salt, a phosphate salt, a chromate salt, a stannate salt and a manganese salt may be coated onto the substrate. The solution may be sprayed, rolled, dipped, or brushed onto the non-oxidized surface.

[0122] The passivation layer comprising a salt selected from a molybdate salt, a vanadate salt, a phosphate salt, a chromate salt, a stannate salt and a manganese salt may be applied under acidic conditions, such as at a pH of from about 2 to about 6. Thus, the solution coated onto the substrate that comprises a salt selected from a molybdate salt, a vanadate salt, a phosphate salt, a chromate salt, a stannate salt and a manganese salt may have a pH of from about 2 to about 6.

[0123] An electrophoretic polymer is applied over the coating layer to form an electrophoretic polymer layer. This layer is formed by an electrophoretic deposition (EPD) process. The EPD process may be an anodic process or a cathodic process.

[0124] The substrate bearing the coating layer is made an electrode of an electrochemical cell. The electrochemical cell also has an inert electrode as the counter electrode and an electrolyte comprising the electrophoretic polymer.

[0125] A potential difference is applied across the electrodes of the electrochemical cell to deposit the electrophoretic polymer over the coating layer.

[0126] The electrolyte may have a concentration of about 1 wt% to about 25 wt%, such as about 5 wt% to about 20 wt %, of the electrophoretic polymer.

[0127] The polymer, in general, has ionizable groups. When the polymer is a negatively charged material, then it will be deposited on the positively charged electrode (anode). When the polymer is a positively charged material, then it will be deposited on the negatively charged electrode (cathode).

[0128] The coating layer and the electrophoretic polymer layer may form a second coated surface. The substrate may already have a first coated surface.

[0129] The first coated surface of a substrate may be cut to expose a non-oxidized surface of the substrate. This process removes a part of the first coated

surface, including, for example, any oxidized layers to expose a shiny surface of the underlying substrate. Part of the first coated surface of the substrate is retained after the cutting process.

[0130] The first coated surface of the substrate may be cut to form a predefined pattern or shape. The cutting process may allow the formation of patterns that will provide a second coated surface having a texture or finish that is different to the texture or finish of the first coated surface.

[0131] The cutting of the first coated surface to expose a non-oxidized surface of the substrate may be by laser cutting or etching, or Computer Numeric Control (CNC) cutting. When the cutting is by laser etching, then, for example, a logo may be formed on the substrate of the housing

[0132] In one example, the cutting is by CNC cutting.

[0133] The method of the present disclosure may include preparing the first coated surface of the substrate. The first coated surface of the substrate is prepared before it is cut to expose a non-oxidized surface of the substrate.

[0134] When the first coated surface comprises an oxidized layer, then the method may involve preparing an oxidized layer on a first surface of the substrate.

[0135] The oxidized layer may be an inorganic layer, which may comprise a passivation layer. The substrate, such as a first surface of the substrate, may be coated with a salt selected from a molybdate salt, a vanadate salt, a phosphate salt, a chromate salt, a stannate salt and a manganese salt. A solution of the salt may be coated onto the substrate.

[0136] The oxidized layer may comprise an oxidized layer of the metallic substrate.

[0137] The oxidized layer may comprise a micro-arc oxide layer, such as a micro-arc oxide layer of the magnesium alloy. The micro-arc oxide layer is prepared by micro-arc oxidation of the substrate, such as a first surface of the substrate.

[0138] Micro-arc oxidation (MAO) is an electrochemical oxidation process that can, for example, generate an oxidized layer on a metallic substrate, such as a substrate comprising a magnesium alloy. MAO involves creating micro-discharges on a surface of the magnesium alloy immersed in an electrolyte to produce a crystalline oxide coating. The resulting micro-arc oxide layer may be ductile and

have a relatively high hardness. Unlike anodizing processes, MAO employs a high potential such that discharges occur. The resulting plasma can modify the structure of the oxide layer. MAO is a chemical conversion process that causes oxidation of the underlying magnesium alloy material, instead of an oxide layer being disposed on to a surface of the magnesium alloy. In comparison to an oxide layer produced by a deposition process, a micro-arc oxide layer may have a higher adhesion to the underlying magnesium alloy.

[0139] The electrolytic solution for MAO may comprise an electrolyte selected from sodium silicate, sodium phosphate, potassium fluoride, potassium hydroxide, sodium hydroxide, fluorozirconate, sodium hexametaphosphate, sodium fluoride, aluminum oxide, silicon dioxide, ferric ammonium oxalate, a salt of phosphoric acid, polyethylene oxide alkylphenolic ether and a combination thereof.

[0140] When the oxidized layer comprises two layers, such as a passivation layer and an oxidized layer of the metallic substrate, then each layer is prepared in a stepwise manner. Thus, for example, the oxidized layer of the metallic substrate, such as a micro-arc oxide layer, may be prepared before the passivation layer.

[0141] When the first coated surface comprises a protective layer, then the method may involve preparing a protective layer on a first surface of the substrate, such as described in the present disclosure. A protective layer selected from a base coating layer, a primer coating layer, a powder coating layer and a top coating layer may be applied to a first surface of the substrate.

[0142] In one example, the first coated substrate comprises an oxidized layer and a protective layer. The oxidized layer is prepared on a first surface of the substrate. The protective layer is then deposited or prepared on the oxidized layer.

[0143] Each protective layer or oxidized layer may be applied to achieve a desired thickness. The thickness of each layer can be measure after it has been applied using, for example, a micrometer screw gauge.

[0144] After cutting the first coated surface of the substrate to expose a non-oxidized surface of the substrate, the non-oxidized surface is coated with either (i) a layer comprising the chelating agent and the metal ion or the chelated metal complex thereof, (ii) a passivation layer or (iii) a passivation layer and a layer

comprising the chelating agent and the metal ion or the chelated metal complex thereof, to form the coating layer. The electrophoretic polymer layer is then applied.

[0145] The combined steps of cutting the first coated surface, coating the non-oxidized surface with anyone of (i) to (iii), and applying the electrophoretic polymer may be performed singly or repeated to provide a plurality of second coated surfaces.

[0146] The method of manufacturing a housing may involve coating both the first coated surface of the substrate and a second coated surface with a transparent top coating layer. This transparent top coating layer may form, or be part of, a third coated surface of the substrate.

[0147] A third coated surface of the substrate may be prepared by applying a top coating layer onto the first coated surface and/or the second coated surface. The top coating layer may be applied onto both the first coated surface and the second coated surface, such as in a single coating step.

[0148] When the third coated surface comprises a first coating layer and a second coating layer, then the first coating layer is applied onto the first coated surface and the second coated surface, and then the second coating layer is applied onto the first coating layer.

[0149] An example of a method of manufacturing a housing of the present disclosure is schematically shown in Figure 1. A substrate 100 is shown having an exposed, non-oxidized surface. In (b) the non-oxidized surface of the substrate is coated with a layer 120 comprising a chelating agent and a metal ion or chelated metal complex thereof. In (c), an electrophoretic polymer layer 130 is applied to the coating layer 120, such as by an electrophoretic deposition process.

[0150] Another example of a method of manufacturing a housing of the present disclosure is illustrated by the flow chart shown in Figure 5. A first coated surface is formed from a passivation layer, a powder coating layer, a primer coating layer, a base coating layer, and a top coating layer. The first coated surface may then be cut by a CNC process or by laser engraving to expose a non-oxidized surface of the substrate. A passivation layer and then an electrophoretic polymer layer may be sequentially applied to the non-oxidized surface of the substrate. The

steps of cutting the substrate and applying both a passivation layer and an electrophoretic polymer layer may be repeated to provide a plurality of coated surfaces.

Electronic device

[0151] The electronic device of the present disclosure may be a computer, a cell phone, a portable networking device, a portable gaming device or a portable GPS. The computer may be portable. When the computer is portable, it may be a laptop or a tablet.

[0152] The electronic device has an electrical circuit, such as a motherboard or display circuitry. The housing may be external to the electrical circuit.

EXAMPLES

[0153] The present disclosure will now be illustrated by the following non-limiting example.

Example 1

[0154] A keyboard casing for a laptop was manufactured from a magnesium alloy substrate. An oxidized surface layer was formed on the magnesium alloy substrate by micro-arc oxidation. The oxidized surface layer was then coated with a primer coating layer. The primer coating layer of polyester was then coated with a base coating layer of polyurethane. The combination of the micro-arc oxidation layer, the primer coating layer and the base coating layer formed a first coated surface of the substrate.

[0155] The substrate was then cut using a CNC cutting process to expose a non-oxidised surface of the substrate. The CNC cutting process was used to cut openings in the casing for a touchpad and for a fingerprint scanner. The CNC cutting process may provide a chamfered edge or a sidewall area where a surface of the substrate is exposed.

[0156] The shiny, exposed areas of the substrate were then coated with a solution comprising a chelated metal complex where the chelating agent is DTTPH and the metal ion was at least one of aluminum, nickel and zinc. The solution was

dried and formed a transparent coating layer that protects the underlying metallic surface of the substrate and prevents it from undergoing atmospheric oxidation.

[0157] By a process of electrophoretic deposition, the electrophoretic polymer, which was a polyacrylic polymer, was applied onto the transparent coating layer containing a chelated metal complex. The electrophoretic polymer layer included Indigotin dye to provide a blue coloration. Without the addition of a pigment or a dye, the CNC chamfer area would have a natural, metallic appearance.

[0158] The attractive metallic lustre of the magnesium alloy substrate remained visible through the second coating layer, which is formed from the layer containing the chelated metal complex and the electrophoretic polymer layer.

CLAIMS

1. A housing for an electronic device comprising:
a substrate comprising a magnesium alloy;
5 an electrophoretic polymer layer overlying the substrate, and
a coating layer positioned between the substrate and the electrophoretic
polymer layer, wherein the coating layer comprises (i) a layer comprising a
chelating agent and a metal ion or chelated metal complex thereof, (ii) a
passivation layer or (iii) a passivation layer and a layer comprising a chelating
10 agent and a metal ion or chelated metal complex thereof.
2. The housing of claim 1, wherein the coating layer comprises a layer
comprising a chelating agent and a metal ion or chelated metal complex thereof,
wherein the chelating agent is selected from ethylenediaminetetraacetic acid,
15 ethylenediamine, nitrilotriacetic acid,
diethylenetriaminepenta(methylenephosphonic acid),
nitrilotris(methylenephosphonic acid) and 1-hydroxyethane-1,1-disphosphonic
acid.
- 20 3. The housing of claim 1, wherein the coating layer comprises a layer
comprising a chelating agent and a metal ion or chelated metal complex thereof,
wherein the metal ion is selected from an aluminum ion, a nickel ion, a chromium
ion, a tin ion, an indium ion and a zinc ion.
- 25 4. The housing of claim 1, wherein the electrophoretic polymer layer
comprises a polymer selected from an epoxy polymer, polyvinylpyrrolidone,
polyethyleneimine, and a polyacrylic polymer.
5. The housing of claim 1, wherein the electrophoretic polymer layer has a
30 thickness of about 5 μm to about 60 μm .
6. The housing of claim 1, wherein the electrophoretic deposition layer
comprises a pigment.

7. The housing of claim 6, wherein the pigment is selected from carbon black, titanium dioxide, clay, mica, talc, barium sulfate, calcium carbonate, synthetic pigment, pearl pigment, metallic powder, aluminum oxide, dye, graphene, graphite, and an inorganic powder.

5

8. The housing of claim 7, wherein pigment particles are dispersed throughout the electrophoretic polymer layer.

9. The housing of claim 1, wherein the substrate has an oxidized layer or an inorganic layer.

10

10. The housing of claim 9, wherein the oxidized layer is a micro-arc oxide layer and the inorganic layer is a passivation layer.

11. A method for manufacturing a housing for an electronic device, comprising: coating a substrate with (i) a layer comprising a chelating agent and a metal ion or a chelated metal complex thereof, (ii) a passivation layer or (iii) a passivation layer and a layer comprising a chelating agent and a metal ion or chelated metal complex thereof, to form a coating layer, wherein the substrate comprises a magnesium alloy; applying an electrophoretic polymer layer over the coating layer.

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12. The method of claim 11, wherein the substrate is coated with a layer comprising a chelating agent and a metal ion or a chelated metal complex thereof, wherein the chelating agent is selected from ethylenediaminetetraacetic acid, ethylenediamine, nitrilotriacetic acid, diethylenetriaminepenta(methylenephosphonic acid), nitrilotris(methylenephosphonic acid) and 1-hydroxyethane-1,1-disphosphonic acid.

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13. The method of claim 11, wherein the substrate is coated with a layer comprising a chelating agent and a metal ion or a chelated metal complex thereof,

wherein the metal ion is selected from an aluminum ion, a nickel ion, a chromium ion, a tin ion, an indium ion and a zinc ion.

14. The method of claim 11, wherein the substrate bearing the coating layer is
5 made an electrode of an electrochemical cell, wherein the electrochemical cell has an inert electrode as the counter electrode and an electrolyte comprising the electrophoretic polymer.

15. The method of claim 14, wherein a potential difference is applied across the
10 electrodes of the electrochemical cell to deposit the electrophoretic polymer over the coating layer.

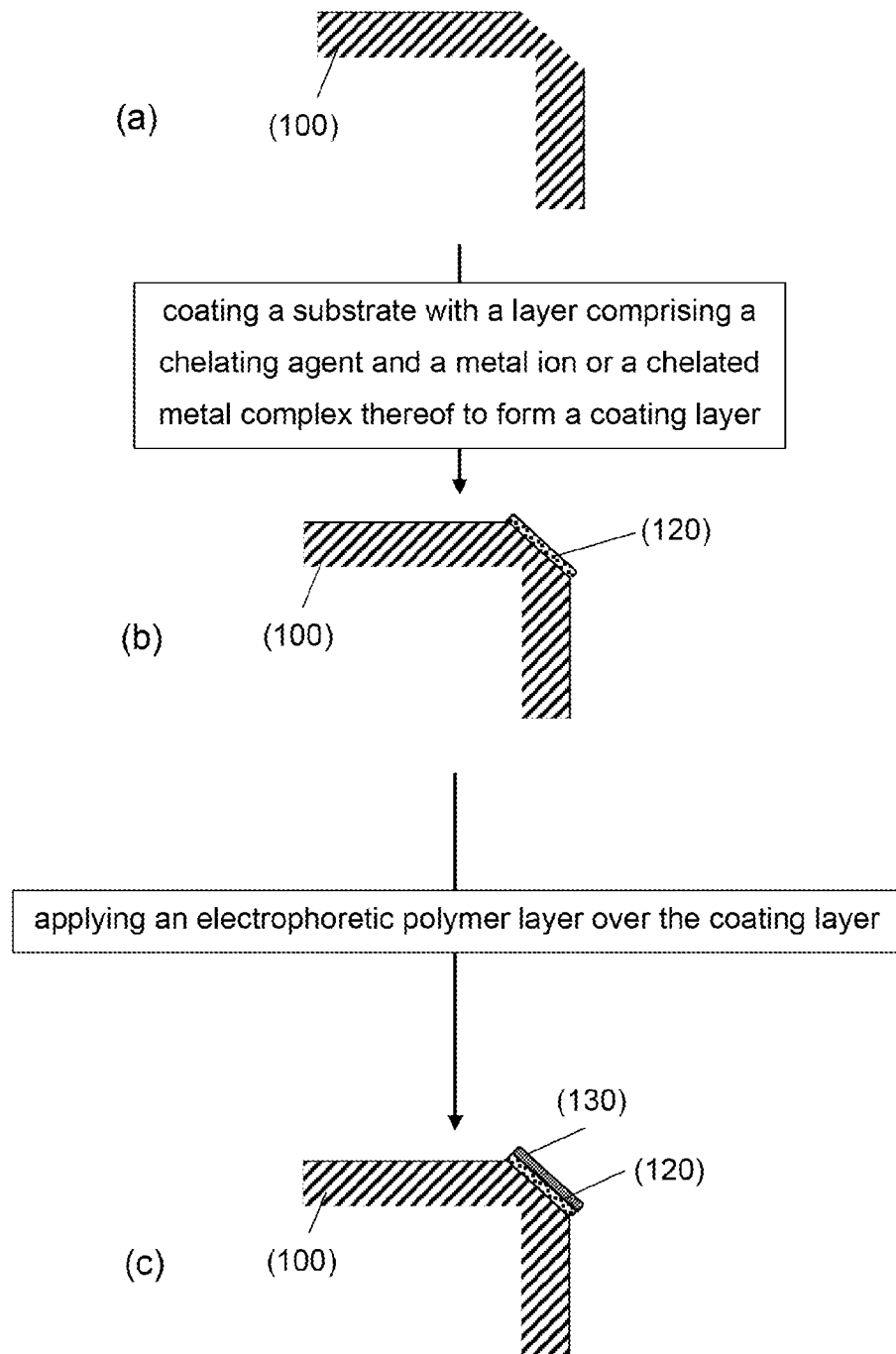


Figure 1

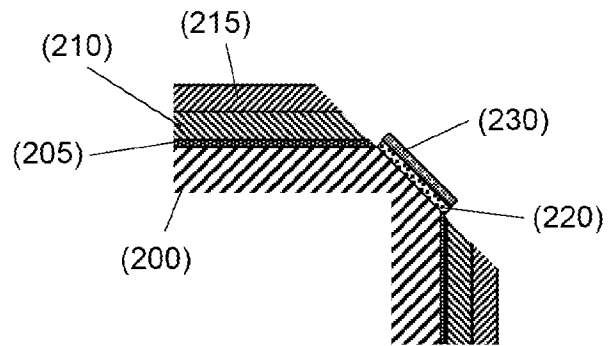


Figure 2

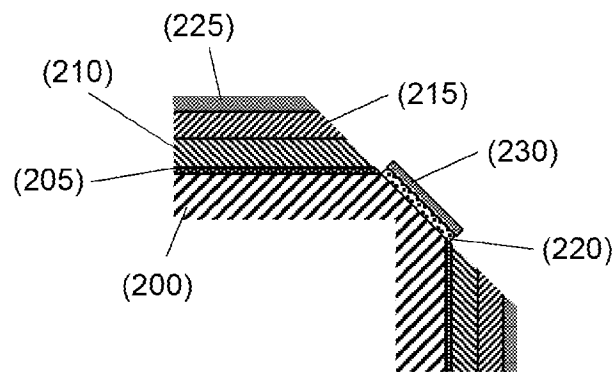


Figure 3

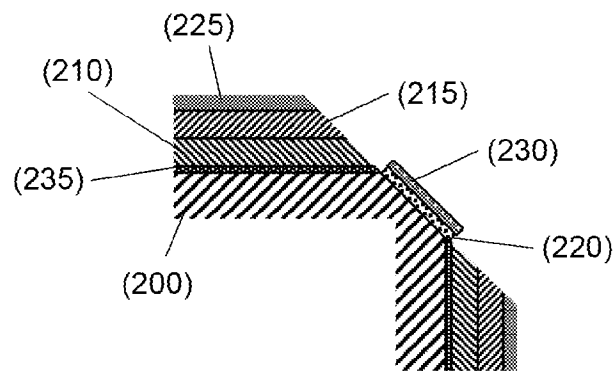


Figure 4

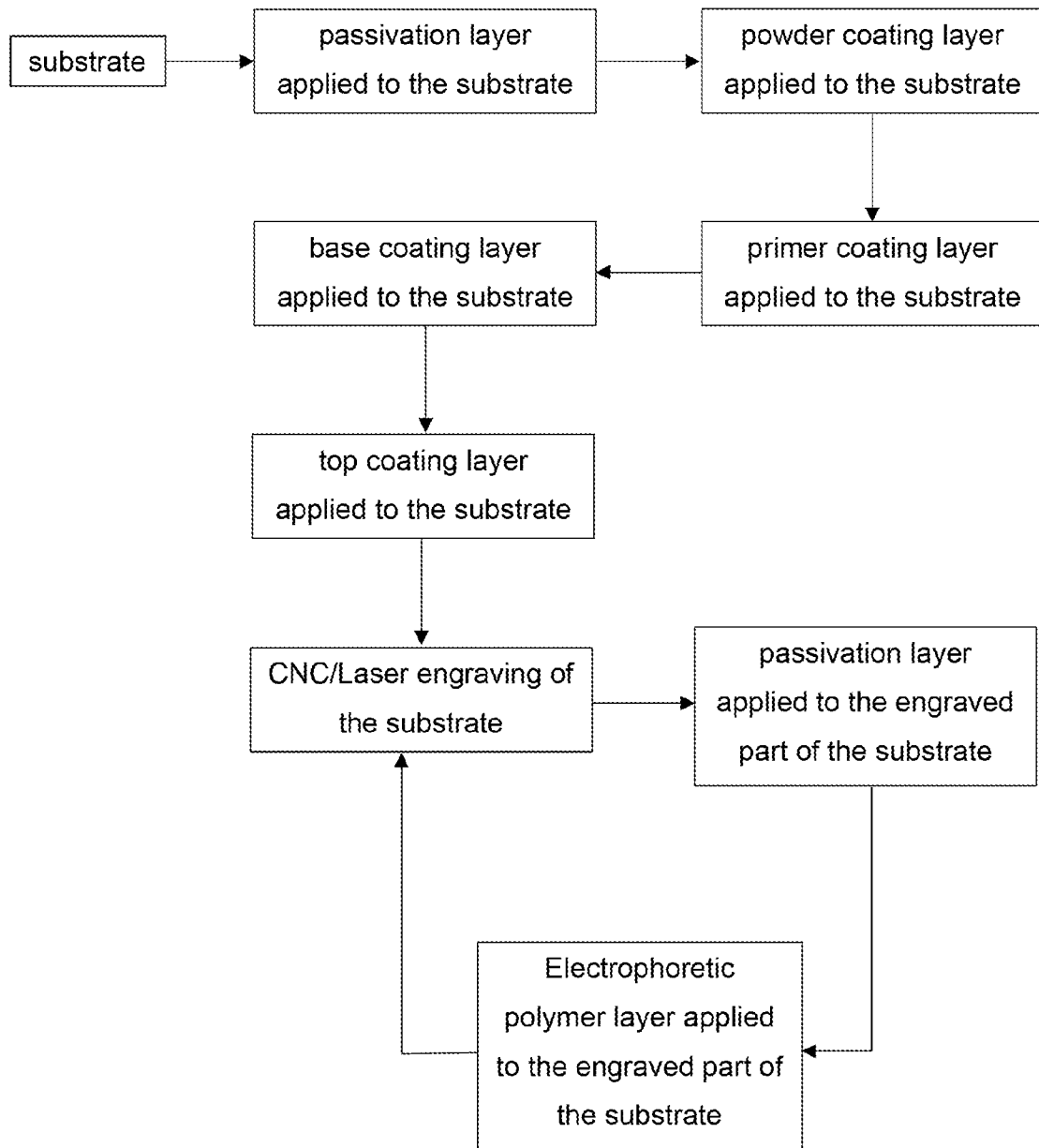
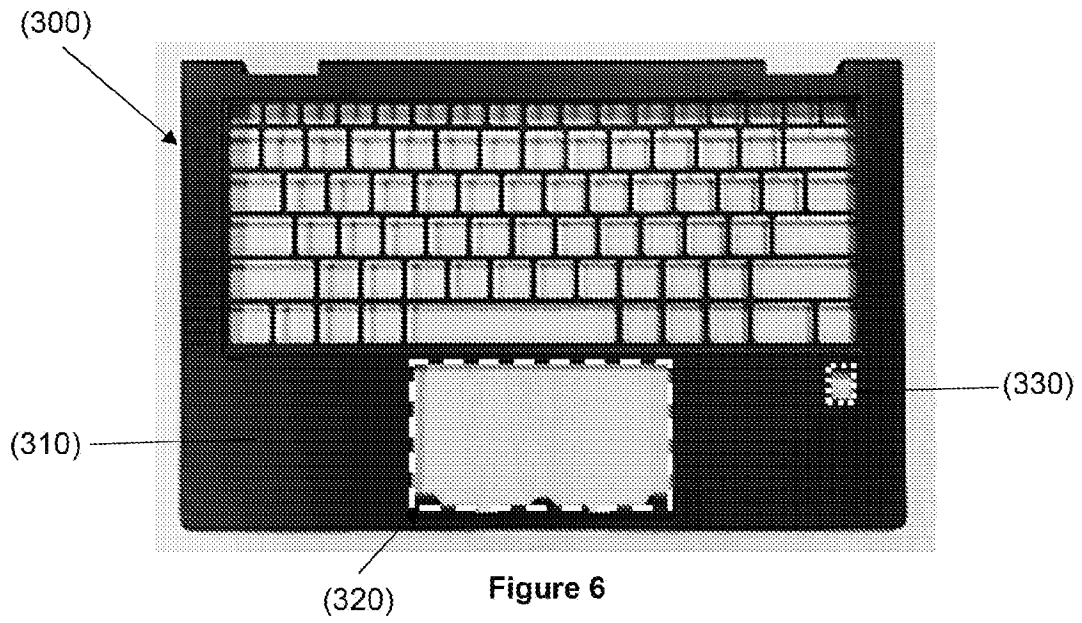


Figure 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2019/012804

A. CLASSIFICATION OF SUBJECT MATTER (see extra sheet) 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) G12B 9/00, 9/02, C23C 23/00, 22/00, C25D 13/00, 13/04, 13/20, 15/00, C23F 11/00, 11/10, 17/00 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.
X Y	US 2008/0041498 A1 (TOSHIO INBE et al.) 21.02.2008, [0002], [0036], [0041], [0041]-[0044], [0094], [0095], [0101], [0106], [0120], [0122], [0124], [0125]	1-3, 11-13 4-10, 14-15
Y	WO 99/02759 A1 (MAGNESIUM TECHNOLOGY LIMITED) 21.01.1999, fig. 3, p. 4, lines 14, 15, c. 11, line 31, p. 12, lines 1, 2, p. 13, lines 10-31, p. 14, lines 1-31, p. 15, lines 1-14, p. 18, lines 16-31, p. 19, line 1, lines 25-31, p. 20, lines 1-9, p. 23, lines 10-31, p. 24, lines 1-16	4-10, 14-15
A	US 5702581 A (HERBERTS GMBH) 30.12.1997	1-15
A	S 2010/0330380 A1 (JOHN COLREAVY et al.) 30.12.2010	1-15
☐ 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 document but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family	
Date of the actual completion of the international search	Date of mailing of the international search report	
19 September 2019 (19.09.2019)	26 September 2019 (26.09.2019)	
Name and mailing address of the ISA/RU: Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	Authorized officer O. Gudkova Telephone No. 8 499 240 25 91	

INTERNATIONAL SEARCH REPORT

Classification of subject matter

International application No.

PCT/US 2019/012804

G12B 9/02 (2006.01)
C23C 23/00 (2006.01)
C23C 22/00 (2006.01)
C25D 13/06 (2006.01)
C25D 13/20 (2006.01)
C25D 15/00 (2006.01)
C23F 17/00 (2006.01)
C23F 11/10 (2006.01)