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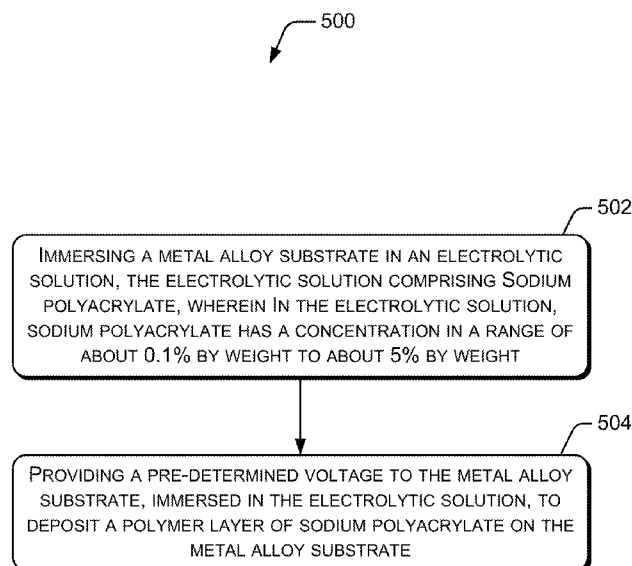


FIG. 5

(57) Abstract: The disclosure herein relates to a polymer coating of metal alloy substrates used in electronic devices. In an example, a metal alloy substrate has an electrolytically deposited polymer layer thereon. The polymer layer is of sodium polyacrylate having a concentration in a range of about 0.1% by weight to about 5% by weight.

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POLYMER COATING OF METAL ALLOY SUBSTRATES

BACKGROUND

[0001] Devices, such as laptops and mobile phones include an exterior body made of different substrates, such as metals, fibers, and composite materials. Metal alloy substrates are generally used for fabrication of the exterior body of the devices. The metal alloy substrates may be made of magnesium, aluminum, titanium, or a combination of similar light weight metals.

BRIEF DESCRIPTION OF DRAWINGS

[0002] The following detailed description references the drawings, wherein:

[0003] FIG. 1 illustrates a sectional view of a polymer coated metal alloy substrate, according to an example of the present application;

[0004] FIG. 2 illustrates a setup for electrolytically coating a polymer layer on a metal alloy substrate, according to an example of the present application;

[0005] FIG. 3 illustrates a sectional view of a polymer coated metal alloy substrate having a paint layer, according to an example of the present application;

[0006] FIG. 4 illustrates a housing of a device, according to an example of the present application;

[0007] FIG. 5 illustrates a method of coating a polymer layer on a metal alloy substrate, according to an example of the present application; and

[0008] FIG. 6 illustrates another method of coating the polymer layer on the metal alloy substrate, according to an example of the present application.

DETAILED DESCRIPTION

Definitions

[0009] For convenience, before further description of the present disclosure, certain terms employed in the specification, and examples are collected here. These

definitions should be read in the light of the remainder of the disclosure and understood as by a person of skill in the art. The terms used herein have the meanings recognized and known to those of skill in the art, however, for convenience and completeness, particular terms and their meanings are set forth below.

[0010] The articles “a”, “an”, and “the” are used to refer to one or to more than one (i.e., to at least one) of the grammatical object of the article.

[0011] The term “about” when referring to a numerical value is intended to encompass the values resulting from variations that can occur during the normal course of performing a method. Such variations are usually within plus or minus 10 percent of the stated numerical value.

[0012] The term “weight percentage” or “wt%”, used herein refers to percentage weight of that component relative to 100% weight of the composition.

[0013] The term “uniform polymer layer” as used herein is defined as a polymer layer having a constant thickness with a variation of no more than 10% or a polymer layer having a constant thickness with a variation of no more than 5% or a polymer layer having a constant thickness with a variation of no more than 3% or a polymer layer having a constant thickness with a variation of no more than 1%.

[0014] The term “immersed” as used herein is defined as an object fully or completely submerged in a solution such that no surface of the object is exposed to environment other than the solution in which the object is submerged.

[0015] The term “without adding any pigment” as used herein is defined as adding a pigment in 0 wt % or adding a pigment in an amount less than 0.5 wt% or adding a pigment in an amount less than 0.4 wt% or adding a pigment in an amount less than 0.3 wt% or adding a pigment in an amount less than 0.2 wt% or adding a pigment in an amount less than 0.1 wt%.

[0016] The term “dark color” or “black color” as used herein is defined as an achromatic color that absorbs 99.5% incident light or an achromatic color that absorbs 99.6% incident light or an achromatic color that absorbs 99.7% incident light or an achromatic color that absorbs 99.8% incident light or an achromatic color that absorbs 99.9% incident light or an achromatic color that absorbs 100% incident light.

[0017] The term “controlled manner” is defined as a setup for conducting electrolysis at a pre-determined voltage and for a pre-defined time period.

[0018] The term “coat”, and variations, such as “coating” and “coated”, used herein refer to deposition on a surface.

[0019] The term “body part” of a device used herein may refer to an enclosure or a housing of the device that may house a component therein. The term “body part” of a device used herein may also refer a body panel of the device.

[0020] Metal alloy substrates made of magnesium, aluminum, titanium, or a combination thereof, are strong and are light in weight. Such metal alloy substrates are generally used for manufacturing housings of electronic devices, such as mobile phones, tablets, laptops, and the like. Metal alloy substrates, such as magnesium alloy substrates, are prone to corrosion which may affect the durability of components made of the metal alloy substrates. To enhance the durability of the components made of metal alloy substrates, the metal alloy substrates are processed through electrochemical surface treatment processes for creating oxide coatings on the metal alloy substrates. For example, the metal alloy substrates are immersed in an electrolytic solution and voltage is applied to the metal alloy substrates. The application of the voltage in presence of the electrolytic solution causes the metal alloy substrate to oxidize. As a result, a ceramic coating is formed on the surface of the metal alloy substrate.

[0021] However, the ceramic coating is of a light color which may not be suitable for the electronic devices, such as for heat dissipation. To obtain a dark color, an

additive, such as carbon black is added in the electrolytic solution that imparts dark color to the ceramic layer formed on the metal alloy substrate. However, carbon black is generally in the form of fine powder and thus does not get properly attached to the surface of the metal alloy surface. As a result, a non-uniform layer is deposited on the metal alloy substrate.

[0022] The present disclosure describes examples of polymer coated metal alloy substrates, methods for coating a polymer layer on a metal alloy substrate, and housings of devices having the polymer coated metal alloy substrates. The method of the present disclosure involves electrolytically coating a uniform polymer layer on a metal alloy substrate. The metal alloy substrate includes magnesium, aluminum, zinc, titanium, lithium, niobium, or combinations thereof. In an example, a metal alloy substrate is immersed in an electrolytic solution. The electrolytic solution includes an anionic polymer, such as sodium polyacrylate, present in an amount from about 0.1% by weight to about 5% by weight of the total weight of the electrolytic solution.

[0023] For coating the polymer layer on the metal alloy substrate, a pre-determined voltage is applied to the metal alloy substrate for a fixed time duration, which electrolyzes the electrolytic solution. In an example, the pre-determined voltage for electrolysis of the electrolytic solution may be provided for a time duration in a range of about 30 seconds to about 60 seconds. In another example, the pre-determined voltage for electrolysis of the electrolytic solution may be provided for a time duration in a range of about 20 seconds to about 50 seconds. In another example, the pre-determined voltage for electrolysis of the electrolytic solution may be provided for a time duration in a range of about 10 seconds to about 40 seconds. As a result of the electrolysis, particles of sodium polyacrylate in the electrolytic solution gets attracted towards the metal alloy substrate and are deposited on the metal alloy substrate to form a layer of sodium polyacrylate on the metal alloy substrate.

[0024] In an example, the polymer layer coated on the metal alloy substrate may have a thickness in a range of about 1 micrometer (μm) to about 5 μm . In another example, the polymer layer coated on the metal alloy substrate may have a thickness in a range of about 0.5 μm to about 4 μm . In another example, the polymer layer coated on the metal alloy substrate may have a thickness in a range of about 0.4 μm to about 3 μm . In yet another example, the polymer layer coated on the metal alloy substrate may have a thickness in a range of about 0.3 μm to about 2 μm . In still another example, the polymer layer coated on the metal alloy substrate may have a thickness in a range of about 0.2 μm to about 1 μm .

[0025] The attachment of sodium polyacrylate particles on the metal alloy substrate at the pre-determined voltage causes a black colored layer to be uniformly formed on the metal alloy substrate. Thus, a dark colored polymer layer is uniformly deposited on the metal alloy substrate without adding any pigment in the electrolytic solution. As the black colored polymer layer absorbs more heat when compared to light colored layers of the polymer, the polymer layer as described herein facilitates effective heat dissipation. In addition, as the polymer layer forms a coating around the metal alloy substrate, the polymer layer thereby prevents the metal alloy substrate from getting corroded.

[0026] Further, when the pre-determined voltage is applied to the metal alloy substrate, a temperature of the metal alloy substrate may rise. In an example, to maintain a temperature of the metal alloy substrate below a pre-defined temperature, a coolant may be circulated around the metal alloy substrate. In an example, the coolant may include Freon, cold water, 0.5-3.0 wt% ethylene glycol, diethylene glycol, propylene glycol in water, polyaliphatic olefins, or a combination thereof. The coolant is circulated in a closed pipe arrangement around the metal alloy substrate, while the metal alloy substrate is immersed in the electrolytic solution during the electrolysis.

[0027] As the pre-determined voltage is applied to the metal alloy substrate for a specific time period, the electrolysis takes place in a controlled manner, thereby facilitating deposition of the uniform polymer layer on the metal alloy substrate. The uniform polymer layer makes the metal alloy substrate resistant against corrosion.

[0028] The following detailed description refers to the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the following description to refer to the same or similar parts. While several examples are described in the description, modifications, adaptations, and other examples are possible. Accordingly, the following detailed description does not limit the disclosed examples. Instead, the proper scope of the disclosed examples may be defined by the appended claims.

[0029] FIG. 1 illustrates a sectional view of a polymer coated metal alloy substrate 100, according to an example of the disclosure. The polymer coated metal alloy substrate 100 includes a metal alloy substrate 102. The metal alloy substrate 102 comprises magnesium, magnesium alloy, aluminum, zinc, titanium, lithium, niobium, or a combination thereof. In an example, the magnesium alloy includes magnesium AZ31B alloy having 96 wt% of magnesium, 3 wt% of aluminum, and 1 wt% of zinc. In another example, the magnesium alloy includes magnesium AZ91D alloy having 90 wt% of magnesium, 9 wt% of aluminum, and 1 wt% of zinc. In yet another example, the magnesium alloy includes magnesium LZ91 alloy having 90 wt% of magnesium, 9 wt% of lithium, and 1 wt% of zinc. In another example, the magnesium alloy includes magnesium LZ141 alloy having 85 wt% of magnesium, 14 wt% of lithium, and 1 wt% of zinc. In still another example, the magnesium alloy includes magnesium ALZ491 alloy having 86 wt% of magnesium, 9 wt% of lithium, 4 wt% of aluminum, and 1 wt% of zinc.

[0030] The polymer coated metal alloy substrate 100, as shown in FIG. 1, also includes a polymer layer 104 on the metal alloy substrate 102. The polymer layer 104 is of an anionic polymer, such as sodium polyacrylate. In an example, the anionic

polymer may have a molecular weight distribution in a range of about 1000 kg/mol to about 2000 kg/mol. In another example, the anionic polymer may have a molecular weight distribution in a range of about 1200 kg/mol to about 1800 kg/mol. In another example, the anionic polymer may have a molecular weight distribution in a range of about 1400 kg/mol to about 1600 kg/mol. The polymer layer 104 may be deposited at all surfaces of the metal alloy substrate 102, as depicted in the sectional view in FIG. 1. Alternatively, the polymer layer 104 may be deposited on one surface of the metal alloy substrate 102.

[0031] In an example, the polymer layer 104 may have a thickness in a range of about 1 μm to about 5 μm . In another example, the polymer layer 104 may have a thickness in a range of about 0.5 μm to about 4 μm . In another example, the polymer layer 104 may have a thickness in a range of about 0.4 μm to about 3 μm . In another example, the polymer layer 104 may have a thickness in a range of about 0.3 μm to about 2 μm . In yet another example, the polymer layer 104 may have a thickness in a range of about 0.2 μm to about 1 μm .

[0032] In an example, the polymer layer 104 is coated or deposited on the metal alloy substrate 102 through electrolysis of an electrolytic solution having the anionic polymer. In an example, the anionic polymer has a concentration in a range of about 0.1% by weight to about 5% by weight based on a total weight of the electrolytic solution. In another example, the anionic polymer has a concentration in a range of about 0.05% to about 4% by weight based on a total weight of the electrolytic solution. In another example, the anionic polymer has a concentration in a range of about 0.04% to about 3% by weight based on a total weight of the electrolytic solution. In yet another example, the anionic polymer has a concentration in a range of about 0.03% to about 2% by weight based on a total weight of the electrolytic solution. In still another example, the anionic polymer has a concentration in a range of about 0.02% to about 1% by weight based on a total weight of the electrolytic solution.

[0033] The metal alloy substrate 102 is immersed in the electrolytic solution and a pre-determined voltage, for example, in a range of about 300 V to about 700 V, is applied to the metal alloy substrate 102 for coating the polymer layer 104. In another example, a pre-determined voltage in a range of about 250 V to about 650 V, is applied to the metal alloy substrate 102 for coating the polymer layer 104. In another example, a pre-determined voltage in a range of about 200 V to about 600 V is applied to the metal alloy substrate 102 for coating the polymer layer 104. In yet another example, a pre-determined voltage in a range of about 150 V to about 550 V is applied to the metal alloy substrate 102 for coating the polymer layer 104. In still another example, a pre-determined voltage in a range of about 100 V to about 500 V is applied to the metal alloy substrate 102 for coating the polymer layer 104. In another example, a pre-determined voltage in a range of about 50 V to about 450 V is applied to the metal alloy substrate 102 for coating the polymer layer 104.

[0034] In an example, the pre-determined voltage may be applied for a time duration in a range of about 3 minutes to about 20 minutes. In another example, the pre-determined voltage may be applied for a time duration in a range of about 2 minutes to about 15 minutes. In another example, the pre-determined voltage may be applied for a time duration in a range of about 1 minute to about 10 minutes. In yet another example, the pre-determined voltage may be applied for a time duration in a range of about 30 seconds to about 5 minutes. In an example, the pre-determined voltage for electrolysis of the electrolytic solution may be provided for a time duration in a range of about 30 seconds to about 60 seconds. In another example, the pre-determined voltage for electrolysis of the electrolytic solution may be provided for a time duration in a range of about 20 seconds to about 50 seconds. In another example, the pre-determined voltage for electrolysis of the electrolytic solution may be provided for a time duration in a range of about 10 seconds to about 40 seconds. An example procedure to coat the polymer layer 104 on the metal alloy substrate 102 is described in detail with reference to FIG. 2.

[0035] In an example, components pertaining to electronic devices, such as body parts, housings, and enclosures of portable or handheld devices may be made of polymer coated metal alloy substrate 100. For this, the metal alloy substrate 102 may be forged, die-casted, computer-numeric control (CNC) machined, or molded, in the shape of the component, prior to coating the polymer layer 104.

[0036] Further, in an example, the metal alloy substrate 102, prior to coating the polymer layer 104, may be cleaned, washed, polished, degreased, and/or activated. The metal alloy substrate may be chemically cleaned using an alkaline agent, for example, sodium hydroxide. The metal alloy substrate may be washed in a buffer solution. The cleaning and washing of the metal alloy substrate may help in removing foreign particles, if any, present on the surface of the metal alloy substrate. Further, the metal alloy substrate may be chemically polished using abrasives to remove irregularities that may be present on the surface of the metal alloy substrate. The metal alloy substrate may also be degreased through ultrasonic degreasing to remove impurities, such as fat, grease, or oil from the surface of the metal alloy substrate. Further, a degreased surface of the metal alloy substrate may also be polished to smoothen the metal alloy substrate. In addition, the metal alloy substrate may also be activated through acid treatment for removing the natural oxide layer, if any, present on the surface of the metal alloy substrate.

[0037] FIG. 2 illustrates a setup 200 for electrolytically coating the polymer layer 104 on the metal alloy substrate 102, according to an example of the present disclosure. The setup 200, as shown, has a container 202 to hold liquids in which a substrate may be immersed for performing electrolysis. In an example, the container 202 may be made of a stainless-steel material. In another example, the container 202 may be made of a titanium material. In yet another example, the container 202 may be made of a glass material. In another example, the container 202 may be made of a plastic material. Further, the container 202 may be cylindrical in shape. In an example, the container 202 may be rectangular in shape. In another example, the container 202 may be square in shape.

[0038] In an example, for coating the polymer layer 104 on the metal alloy substrate 102, an electrolytic solution 204 comprising an anionic polymer is poured into the container 202. The anionic polymer may be sodium polyacrylate. The anionic polymer may have a concentration in a range of about 0.1% by weight to about 5% by weight, or about 0.05% to about 4% by weight, or about 0.04% to about 3% by weight, or about 0.03% to about 2% by weight, or about 0.02% to about 1% by weight. In an example, the electrolytic solution 204 with the anionic polymer may have a pH value in a range of 9 to 12. In another example, the electrolytic solution 204 with the anionic polymer may have a pH value in a range of 9.5 to 11.5. In another example, the electrolytic solution 204 with the anionic polymer may have a pH value in a range of 10 to 11. In another example, the electrolytic solution 204 with the anionic polymer may have a pH value in a range of 10.5 to 11.5.

[0039] Further, the electrolytic solution 204 may be maintained at a temperature in range of 25° Celsius (C) to 45°C. In an example, the electrolytic solution 204 may be maintained at a temperature in range of 28°C to 42°C. In another example, electrolytic solution 204 may be maintained at a temperature in range of 31°C to 39°C. In another example, the electrolytic solution 204 may be maintained at a temperature in range of or 34°C to 36°C.

[0040] In an example, the electrolytic solution 204 may include sodium silicate, metal phosphate, potassium fluoride, potassium hydroxide, sodium hydroxide, fluorozirconate, sodium fluoride, ferric ammonium oxalate, or combinations thereof. In an example, potassium hydroxide or sodium hydroxide has a concentration in a range of about 0.3 wt% to about 3.0 wt% or about 0.2 to about 2.0 wt% or about 0.3 wt% to about 1.0 wt%. In an example, potassium fluoride or sodium fluoride has a concentration in a range of about 0.5 wt% to about 1.0 wt% or about 0.6 wt% to about 0.9 wt% or about 0.7 wt% to about 0.8 wt%. In an example, metal phosphate has a concentration in a range of about 0.3 wt% to about 0.8 wt% or about 0.2 wt% to about 0.7 wt% or about 0.1 wt% to about 0.6 wt%. In an example, sodium silicate has a concentration in a range of about 0.8 wt% to about 2.0 wt% or about 0.7 wt% to about

1 wt% or about 0.6 wt% to about 0.9 wt%. In an example, fluorozirconate has a concentration in a range of about 0.3 wt% to about 0.8 wt% or about 0.2 wt% to about 0.7 wt% or about 0.1 wt% to about 0.6 wt%. In an example, ferric ammonium oxalate has a concentration in a range of about 0.3 wt% to about 0.6 wt% or about 0.2 wt% to about 0.5 wt% or about 0.1 wt% to about 0.4 wt%. In an example, sodium polyacrylate has a concentration in a range of about 0.5 wt% to about 5.0 wt% or about 0.4 wt% to about 4.0 wt% or about 0.3 wt% to about 3.0 wt%.

[0041] After pouring the electrolytic solution 204 in the container 202, the metal alloy substrate 102 is completely immersed as an anode terminal in the electrolytic solution 204. Also, a stainless-steel block or a graphite block, is completely immersed as a cathode terminal 206 in the electrolytic solution 204. In an example, the cathode terminal 206 may be formed of 100% stainless-steel or about 95% stainless-steel or about 90% stainless-steel. In another example, the cathode terminal 206 may be formed of 100% graphite or about 95% graphite or about 90% graphite.

[0042] For this, the metal alloy substrate 102 and the cathode 206 are electrically connected to a positive terminal 210 and a negative terminal 212 of a voltage source 208, respectively, and immersed in the electrolytic solution 204. The voltage source 208 may be a constant voltage source or a variable voltage source that can apply the pre-determined voltage in a range of 300 V to 700 V. In an example, the voltage source 208 can apply the pre-determined voltage in a range of about 250 V to about 650 V or in a range of about 200 V to about 600 V or in a range of about 150 V to about 550 V or in a range of about 100 V to about 500 V or in a range of about 50 V to about 450 V.

[0043] In an example, the metal alloy substrate 102 may be formed in a shape of a component that is to be made of the polymer coated metal alloy substrate. Also, the metal alloy substrate may be cleaned, washed, polished, degreased, and/or

activated, in a manner as described above, before coating a polymer layer on the metal alloy substrate 102.

[0044] After immersing the metal alloy substrate 102 and the cathode 206 in the electrolytic solution 204, the voltage source 208 may be switched ON to provide the pre-determined voltage across the metal alloy substrate 102 and the cathode 206. The pre-determined voltage electrolyzes the electrolytic solution 204, which causes negatively charged particles 214 of the anionic polymer, present in the electrolytic solution 204, to move towards the anode terminal, i.e., the metal alloy substrate 102. As a result, the negatively charged particles 214 of anionic polymer attach with the metal alloy substrate 102 to form the polymer layer.

[0045] Further, in an example, the pre-determined voltage for electrolysis of electrolytic solution 204 may be provided for a fixed time duration. In an example, the pre-determined voltage for electrolysis of the electrolytic solution 204 may be provided for a time duration in a range of about 30 seconds to about 60 seconds. In another example, the pre-determined voltage for electrolysis of the electrolytic solution 204 may be provided for a time duration in a range of about 20 seconds to about 50 seconds or in a range of about 10 seconds to about 40 seconds or in a range of about 5 seconds to about 30 seconds.

[0046] Once the pre-determined voltage is applied for the fixed time duration, the application of the pre-determined voltage may be stopped for a pre-defined time period, before again applying the pre-determined voltage. In an example, the application of the pre-determined voltage may be stopped for about 3 seconds to about 5 seconds. In another example, the application of the pre-determined voltage may be stopped for a time period of about 2 seconds to about 4 seconds. In another example, the application of the pre-determined voltage may be stopped for about 1 second to about 3 seconds.

[0047] In an aspect, when the pre-determined voltage is provided, the temperature of the metal alloy substrate 102 may rise. For example, the temperature

of the electrolytic solution may raise instantaneously to about 5000°C upon application of the pre-determined voltage. In another example, the temperature of the electrolytic solution may raise instantaneously to about 4000°C upon application of the pre-determined voltage. In another example, the temperature of the electrolytic solution may raise instantaneously to about 3000°C upon application of the pre-determined voltage. A high temperature of the metal alloy substrate 102 may cause hindrance in deposition of the polymer layer 104. Therefore, the setup 200 of the disclosure includes a cooling unit 216 for pumping a coolant around the metal alloy substrate 102.

[0048] In an example, the coolant may include Freon, cold water, 0.5-3.0 wt% ethylene glycol, diethylene glycol, propylene glycol in water, polyaliphatic olefins, or a combination thereof. The cooling unit 216 includes a closed pipe system for circulating the coolant. In an example, the cooling unit 216 includes a duct 218 surrounding the metal alloy substrate 102 and the cathode 206, through which the coolant is circulated. In an example, the coolant is circulated during the electrolysis so as to absorb the heat from the metal alloy substrate 102. As a result, the coolant prevents the temperature of the metal alloy substrate 102 to exceed the pre-determined temperature. In an example, the entire process of coating the polymer layer on the metal alloy substrate 102 takes about 5 minutes to about 25 minutes. In another example, the entire process of coating the polymer layer on the metal alloy substrate 102 takes about 4 minutes to about 20 minutes. In another example, the entire process of coating the polymer layer on the metal alloy substrate 102 takes about 3 minutes to about 15 minutes. In yet another example, the entire process of coating the polymer layer on the metal alloy substrate 102 takes about 2 minutes to about 10 minutes. In another example, the entire process of coating the polymer layer on the metal alloy substrate 102 takes about 1 minute to about 5 minutes.

[0049] After this time duration, the voltage source 208 and the cooling unit 216 are switched OFF, and the metal alloy substrate 102, coated with the polymer layer, is removed from the electrolytic solution 204. In an example, the polymer layer

coated on the metal alloy substrate 102 may have a thickness in a range of about 1 μm to about 5 μm or about 0.5 μm to about 4 μm or about 0.4 μm to about 3 μm or about 0.3 μm to about 2 μm or about 0.2 μm to about 1 μm .

[0050] It may be noted that the pre-determined voltage from the voltage source 208, the pre-defined temperature of the metal alloy substrate 102, and the time duration for which the voltage source 208 is switched ON, may vary depending on the type of metal alloy substrate 102 and the type of anionic polymer in the electrolytic solution 204.

[0051] In an example, one or more than one paint layer may be coated on the polymer coated metal alloy substrate 100. The paint layer may be coated by a spray coating process. In one example, the paint layer may include one of a primer coating layer, a base coating layer, a top coating layer, and an anti-fingerprint coating layer. In an example, the primer coating layer may be a resin layer of polyurethane copolymer. The thickness of the primer coating layer may be in a range of about 5 μm to about 20 μm . In an example, the thickness of the primer coating layer may be in a range of about 4 μm to about 15 μm . In another example, the thickness of the primer coating layer may be in a range of about 3 μm to about 10 μm .

[0052] Further, the base coating layer may be a resin layer of polyurethane copolymer and include fillers such as carbon black, titanium dioxide, clay, mica, talc, barium sulfate, calcium carbonate, synthetic pigment, metallic powder, aluminum oxide, organic and/or inorganic powders, plastic beads, color pigments, dyes, and combinations thereof. The thickness of the base coating layer may be in a range of about 10 μm to about 20 μm . In an example, the thickness of the base coating layer may be in a range of about 12 μm to about 18 μm . In another example, the thickness of the base coating layer may be in a range of about 14 μm to about 16 μm .

[0053] Further, in an example, the top coating layer may include resin such as polyurethane, acrylate-urethane, polyacrylic, polyester, or combinations thereof. The thickness of the top coating layer may be in a range of about 10 μm to about 25 μm .

In an example, the thickness of the top coating layer may be in a range of about 12 μm to about 23 μm . In another example, the thickness of the top coating layer may be in a range of about 15 μm to about 20 μm .

[0054] As mentioned above, the paint layer may include an anti-fingerprint coating layer. In an example, the anti-fingerprint coating layer may be a layer of fluoropolymer. The thickness of the anti-fingerprint coating layer may be in a range of about 20 nanometers (nm) to about 1 μm . In an example, the thickness of the anti-fingerprint coating layer may be in a range of about 200 nm to about 0.5 μm . In another example, the thickness of the base coating layer may be in a range of about 500 nm to about 0.1 μm .

[0055] FIG. 3 illustrates a sectional view 300 of the polymer coated metal alloy substrate 100 having a paint layer 302, according to an example of the present application. In an example, the paint layer 302 may be spray coated at one surface on the polymer layer 104 (as depicted in FIG. 3) of the polymer coated metal alloy substrate 100. Alternatively, the paint layer 302 may be deposited around all surfaces of the polymer layer 104. After spray coating the paint layer 302, the polymer coated metal alloy substrate 100 may be heated. This heating of the metal alloy substrate may cure the paint layer 302.

[0056] FIG. 4 illustrates a housing 400 of an electronic device (not shown), according to an example of the disclosure. The housing 400 may include a polymer coated metal alloy substrate 402. In an example, the polymer coated metal alloy substrate 402 includes a metal alloy substrate 404. The metal alloy substrate 404 may include one of magnesium, aluminum, zinc, titanium, lithium, niobium, or a combination thereof. In an example, the polymer coated metal alloy substrate 402 also includes a polymer layer 406 on the metal alloy substrate 404. The polymer layer 406 is of an anionic polymer, such as sodium polyacrylate.

[0057] The polymer layer 406 is coated on the metal alloy substrate 404 through electrolysis of an electrolytic solution having the anionic polymer. Further, the anionic

polymer has a concentration in a range of about 0.1% by weight to about 5% by weight or about 0.05% to about 4% by weight or about 0.04% to about 3% by weight or about 0.03% to about 2% by weight or about 0.02% to about 1% by weight, based on a total weight of the electrolytic solution. The metal alloy substrate 404 is immersed in the electrolytic solution and a pre-determined voltage, in a range of about 300 V to about 700 V, is applied to the metal alloy substrate 404 for coating the polymer layer 406. In an example, a pre-determined voltage is applied in a range of about 250 V to about 650 V or in a range of about 200 V to about 600 V or in a range of about 150 V to about 550 V or in a range of about 100 V to about 500 V or in a range of about 50 V to about 450 V.

[0058] In an example, the polymer coated metal alloy substrate 402 includes a paint layer 408 deposited on the polymer layer 406. It may be noted that in FIGS. 3 and 4, the paint layer is shown on one side/surface of the polymer coated metal alloy substrate. In an example, the paint layer may be coated on multiple surfaces of the polymer coated metal alloy substrate. A surface of the polymer coated metal alloy substrate which may be exposed to the environment, when the polymer coated metal alloy substrate is used as a component of a device, is coated with the paint layer.

[0059] FIG. 5 illustrates a method 500 of coating a polymer layer on a metal alloy substrate, according to an example. The polymer layer may be the polymer layer 104 coated on the metal alloy substrate 102 to obtain the polymer coated metal alloy substrate 100, as described above. The metal alloy substrate may include magnesium, aluminum, zinc, titanium, lithium, niobium, or a combination thereof. The metal alloy substrate may be formed in a shape of a component, such as a body part of a device. As described earlier, the metal alloy substrate may be cleaned, washed, polished, degreased, and/or activated, prior to coating a NIP layer on the metal alloy substrate.

[0060] At block 502 of the method 500, the metal alloy substrate is immersed in an electrolytic solution including sodium polyacrylate. The concentration of sodium

acrylate in the electrolytic solution has a range of about 0.1% to about 5% by weight, or about 0.05% to about 4% by weight, or about 0.04% to about 3% by weight, or about 0.03% to about 2% by weight, or about 0.02% to about 1% by weight. The metal alloy substrate may be immersed as an anode terminal in the electrolytic solution. In addition, a stainless-steel or a graphite block may be immersed as a cathode terminal in the electrolytic solution.

[0061] At block 504, a pre-determined voltage is provided to the metal alloy substrate, immersed in the electrolytic solution, to deposit a polymer layer of the anionic polymer on the metal alloy substrate. The pre-determined voltage may be in a range of 300 V to 700 V, or about 250 V to about 650 V, or about 200 V to about 600 V, or about 150 V to about 550 V, or about 100 V to about 500 V, or about 50 V to about 450 V. In an example, the polymer layer coated on the metal alloy substrate 102 may have a thickness in a range of 1 micrometer to 5 micrometers.

[0062] In an example, the electrolytic solution may be held in a container, and the predetermined voltage is provided to the metal alloy substrate. In an example, the container may be made of a stainless-steel material. In another example, the container may be made of a titanium material. In yet another example, the container may be made of a glass material. In another example, the container may be made of a plastic material. Further, the container may be cylindrical in shape. In an example, the container may be rectangular in shape. In another example, the container may be square in shape.

[0063] The pre-determined voltage may be provided to the metal alloy substrate for a pre-defined time duration, after which the metal alloy substrate, coated with the polymer layer, is removed from the electrolytic solution. In an example, the pre-determined voltage for electrolysis of electrolytic solution may be provided for a time duration in a range of about 3 minutes to about 20 minutes, or about 2 minutes to about 15 minutes, or about 1 minute to about 10 minutes, or about 30 seconds to about 5 minutes. In another example, the pre-determined voltage for electrolysis of

the electrolytic solution may be provided for a time duration in a range of about 30 seconds to about 60 seconds or about 20 seconds to about 50 seconds or about 10 seconds to about 40 seconds.

[0064] FIG. 6 illustrates another method 600 of coating a polymer layer on a metal alloy substrate, according to an example of the present disclosure. At block 602 of the method 600, the metal alloy substrate is degreased to remove impurities from a surface of the metal alloy substrate. For example, the metal alloy substrate may be degreased through ultrasonic degreasing to remove impurities, such as fat, grease, or oil from the surface of the metal alloy substrate.

[0065] At block 604 of the method 600, a degreased surface of the metal alloy substrate is polished to smoothen the metal alloy substrate. For example, the metal alloy substrate is polished by immersing the degreased surface of the metal alloy substrate in a polishing composition. In another example, the metal alloy substrate may be polished with a sandpaper.

[0066] At block 606 of the method 600, the degreased and polished metal alloy substrate is immersed as an anode in an electrolytic solution. The electrolytic solution includes sodium polyacrylate of concentration in a range of about 0.1% to about 5% by weight, or about 0.05% to about 4% by weight, or about 0.04% to about 3% by weight, or about 0.03% to about 2% by weight, or about 0.02% to about 1% by weight. Further, a stainless-steel block or a graphite block may be immersed as a cathode in the electrolytic solution.

[0067] At block 608 of the method 600, a pre-determined voltage is provided to the metal alloy substrate while immersed in the electrolytic solution, to deposit a polymer layer on the metal alloy substrate. The pre-determined voltage may be in a range of about 300 V to about 700 V or about 250 V to about 650 V or in a range of about 200 V to about 600 V or in a range of about 150 V to about 550 V or in a range of about 100 V to about 500 V or in a range of about 50 V to about 450 V.. Further, the polymer layer so formed on the metal alloy substrate may have a thickness in a

range of about 1 μm to about 5 μm or about 0.5 μm to about 4 μm or about 0.4 μm to about 3 μm or about 0.3 μm to about 2 μm or about 0.2 μm to about 1 μm .

[0068] At block 610 of the method 600, a coolant is circulated, during electrolysis, around the metal alloy substrate to absorb excessive heat from the metal alloy substrate and maintain a temperature of the metal alloy substrate below a pre-defined temperature. In an example, the coolant may be cold water, 0.5-3.0 wt% ethylene glycol, diethylene glycol, propylene glycol in water, polyaliphatic olefins, or a combination thereof.

[0069] Further, at block 612 of the method 600, the metal alloy substrate, coated with the polymer layer, is removed from the electrolytic solution, a paint layer may be spray coated on the polymer layer. In an example, the paint layer may include one of a primer coating layer, a base coating layer, a top coating layer, and an anti-fingerprint coating layer.

EXAMPLES

[0070] The description hereinafter describes prophetic examples, which are intended to illustrate examples of the present disclosure and not intended to be taken restrictively to imply any limitations on the scope of the present disclosure. Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this disclosure belongs. It is to be understood that this disclosure is not limited to the particular methods and experimental conditions described, as such methods and conditions may vary depending on the process and inputs used as will be easily understood by a person skilled in the art.

Prophetic Example 1

[0071] A magnesium alloy substrate is immersed in an electrolytic solution as an anode terminal. The electrolytic solution may include sodium polyacrylate, having a concentration, in the electrolytic solution, of about 4% by weight based on a total weight of the electrolytic solution.

[0072] After immersing the magnesium alloy substrate, a voltage of about 200 V is applied to the magnesium alloy substrate for about 2 minutes. As a result of the voltage, a temperature of the magnesium alloy substrate rises, therefore, during the electrolysis, Freon is circulated in a closed pipe arrangement around the magnesium alloy substrate as a coolant. The coolant maintains a temperature of the magnesium alloy substrate below 4000°C.

[0073] The application of the voltage results in coating a polymer layer of thickness of about 3 μm on the magnesium alloy substrate.

[0074] Further, a paint layer is spray coated on the polymer layer. The paint layer is coated as a base coating layer on the polymer layer. The base coating layer is of polyurethane copolymer having titanium dioxide as a filler and has a thickness of 3 μm .

Prophetic Example 2

[0075] A titanium substrate is immersed in an electrolytic solution as an anode terminal. The electrolytic solution includes sodium polyacrylate having a concentration, in the electrolytic solution, of about 3% by weight based on a total weight of the electrolytic solution. Prior to immersing the titanium substrate, the titanium substrate is degreased through ultrasonic degreasing to remove impurities, such as fat, grease, or oil from the surface of the titanium substrate. Further, a degreased surface of the titanium substrate is polished to smoothen the titanium substrate.

[0076] After immersing the titanium substrate, a voltage of about 500 V is applied to the titanium substrate for about 60 seconds. As a result of the voltage, a temperature of the magnesium alloy substrate rises, therefore, during the electrolysis, solution of water and glycol is circulated in a closed pipe arrangement around the titanium substrate as a coolant. The coolant maintains a temperature of the titanium substrate below 3000°C. The application of the voltage results in coating a polymer layer of thickness of about 0.5 μm on the magnesium alloy substrate.

[0077] Further, a paint layer is spray coated on the polymer layer. The paint layer is coated as a top coating layer on the polymer layer. The top coating layer is of acrylate-urethane having a thickness of 15 μm .

[0078] Although examples for the present disclosure have been described in language specific to structural features and/or methods, it is to be understood that the appended claims are not limited to the specific features or methods described herein. Rather, the specific features and methods are disclosed and explained as examples of the present disclosure.

We claim:

1. A method of coating a polymer layer on a metal alloy substrate, the method comprising:

immersing the metal alloy substrate in an electrolytic solution, the electrolytic solution comprising sodium polyacrylate, wherein in the electrolytic solution, sodium polyacrylate has a concentration in a range of about 0.1% by weight to about 5% by weight based on a total weight of the electrolytic solution; and

applying a pre-determined voltage to the metal alloy substrate, immersed in the electrolytic solution, coating the polymer layer of sodium polyacrylate on the metal alloy substrate.

2. The method as claimed in claim 1, wherein the method comprising, circulating a coolant around the metal alloy substrate, while the pre-determined voltage is applied to the metal alloy substrate, to maintain a temperature of the metal alloy substrate below a pre-defined temperature.

3. The method as claimed in claim 1, wherein the metal alloy substrate, immersed in the electrolytic solution, is coupled to a positive terminal of a voltage source applying the pre-determined voltage.

4. The method as claimed in claim 3, comprising immersing a stainless-steel block or a graphite block in the electrolytic solution, wherein the stainless-steel block or the graphite block is coupled to a negative terminal of the voltage source applying the pre-determined voltage.

5. The method as claimed in claim 1, wherein prior to immersing the metal alloy substrate in the electrolytic solution, the method comprising:

degreasing the metal alloy substrate to remove impurities from a surface of the metal alloy substrate; and

polishing a degreased surface of the metal alloy substrate to smoothen the metal alloy substrate.

6. The method as claimed in claim 5, comprising coating a paint layer on the polymer layer deposited on the metal alloy substrate.

7. The method as claimed in claim 1, wherein the pre-determined voltage is in a range of about 300 volts to about 700 volts.

8. A polymer coated metal alloy substrate comprising:

a metal alloy substrate; and

an electrolytically coated polymer layer of an anionic polymer, the anionic polymer being sodium polyacrylate, wherein in the electrolytically coated polymer layer, the anionic polymer has a concentration in a range of about 0.1% by weight to about 5% by weight.

9. The polymer coated metal alloy substrate as claimed in claim 8, wherein the electrolytically coated polymer layer has a thickness in a range of about 1 micrometer to about 5 micrometers.

10. The polymer coated metal alloy substrate as claimed in claim 8 further comprising:

a paint layer on the electrolytically coated polymer layer.

11. The polymer coated metal alloy substrate as claimed in claim 10, wherein the paint layer comprises one of a base coat, a top coat, and an anti-fingerprint coat.

12. An electronic device comprising the polymer coated metal alloy substrate as claimed in claim 8.

13. A housing of an electronic device comprising:

a polymer coated metal alloy substrate comprising:

a metal alloy substrate; and

an electrolytically coated polymer layer of an anionic polymer, the anionic polymer being sodium polyacrylate, wherein in the electrolytically coated polymer layer, the anionic polymer has a concentration in a range of about 0.1% by weight to about 5% by weight; and

a paint layer deposited on the polymer coated metal alloy substrate.

14. The housing as claimed in claim 13, wherein the metal alloy substrate comprises magnesium, magnesium alloy, aluminum, titanium, lithium, niobium, steel, copper, or a combination thereof.

15. The housing as claimed in claim 13, wherein the an electrolytically coated polymer layer has a thickness in a range of about 1 micrometer to about 5 micrometers.

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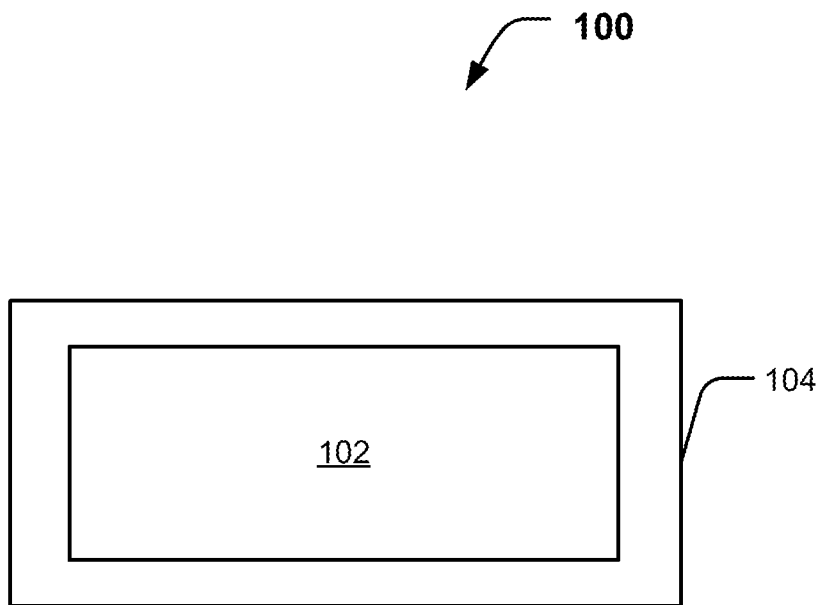


FIG. 1

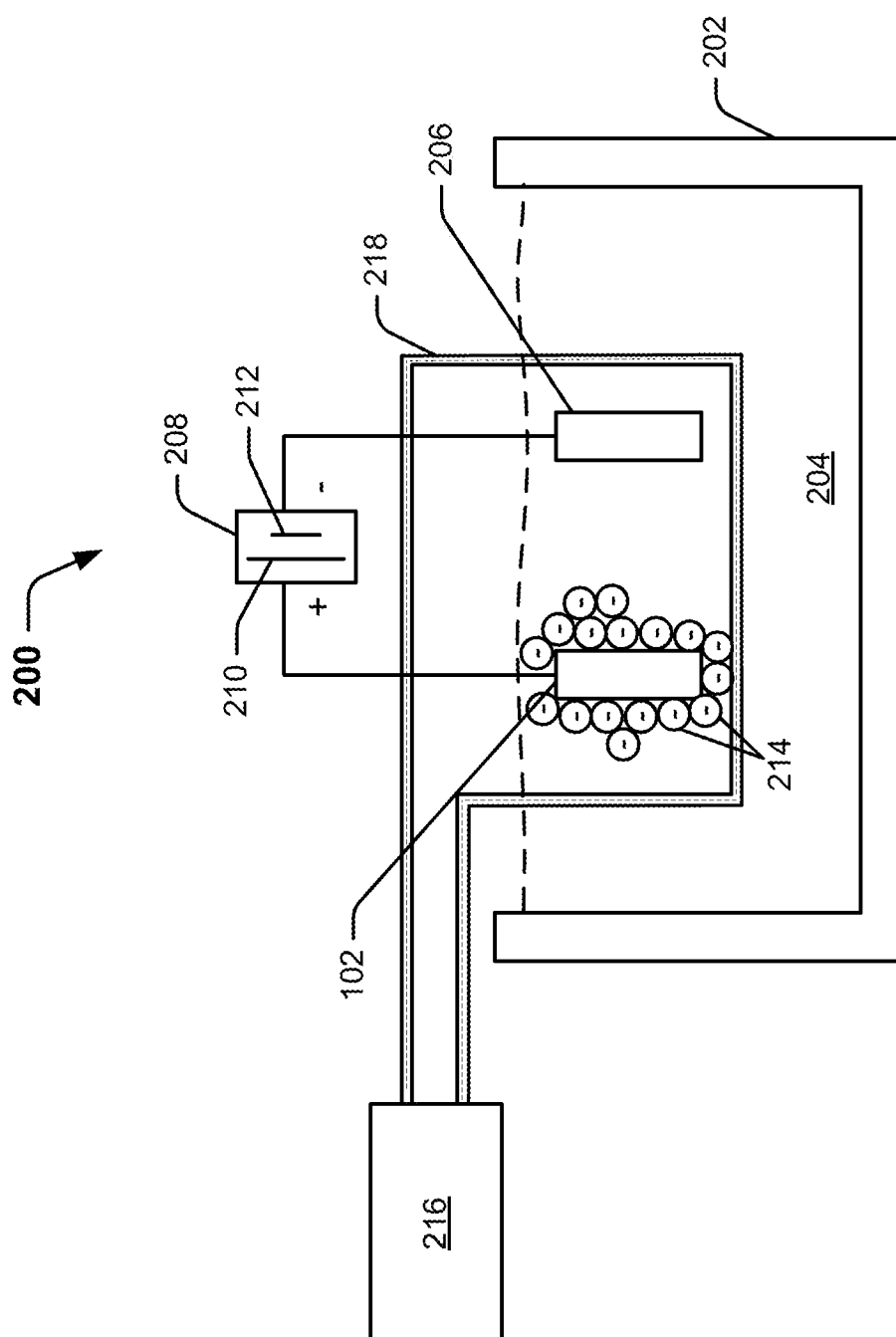


FIG. 2

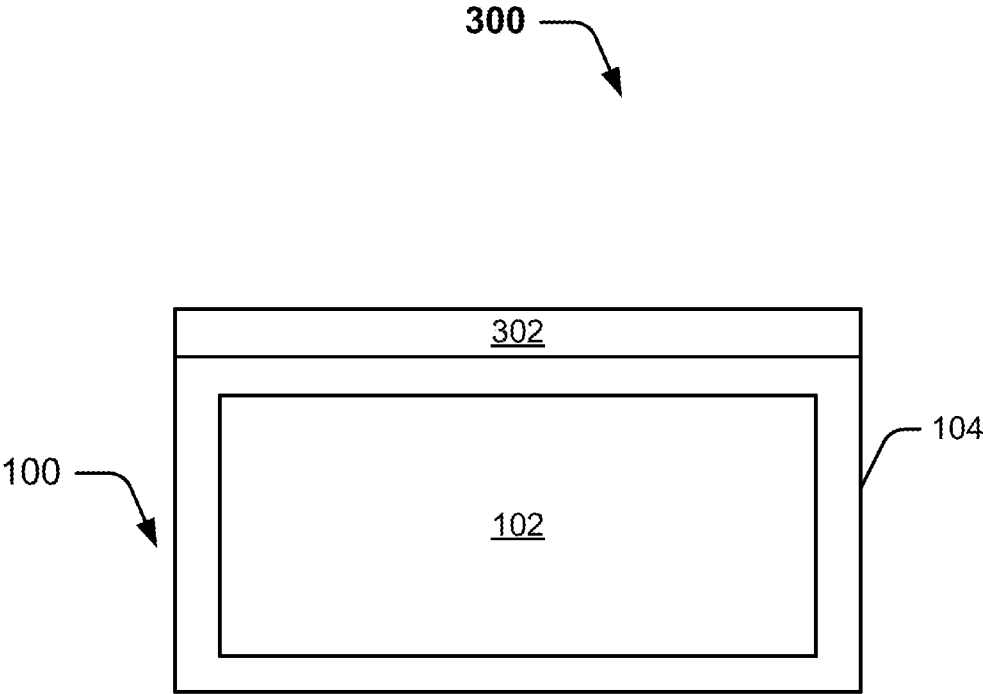


FIG. 3

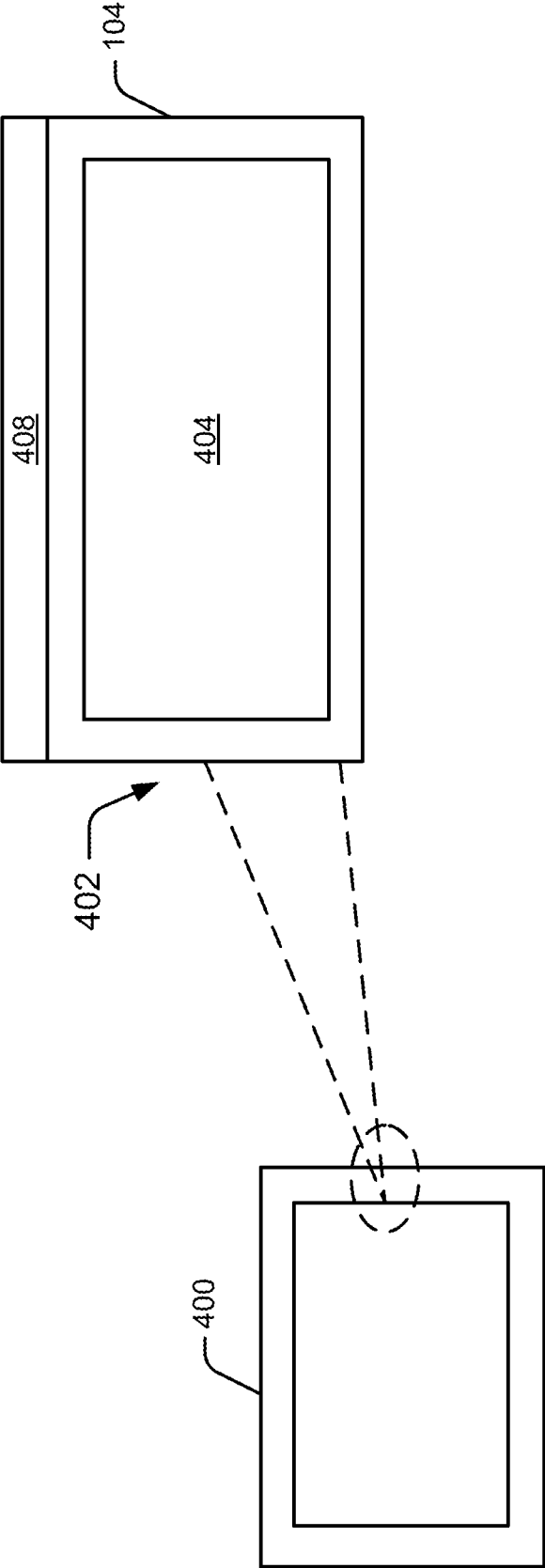


FIG. 4

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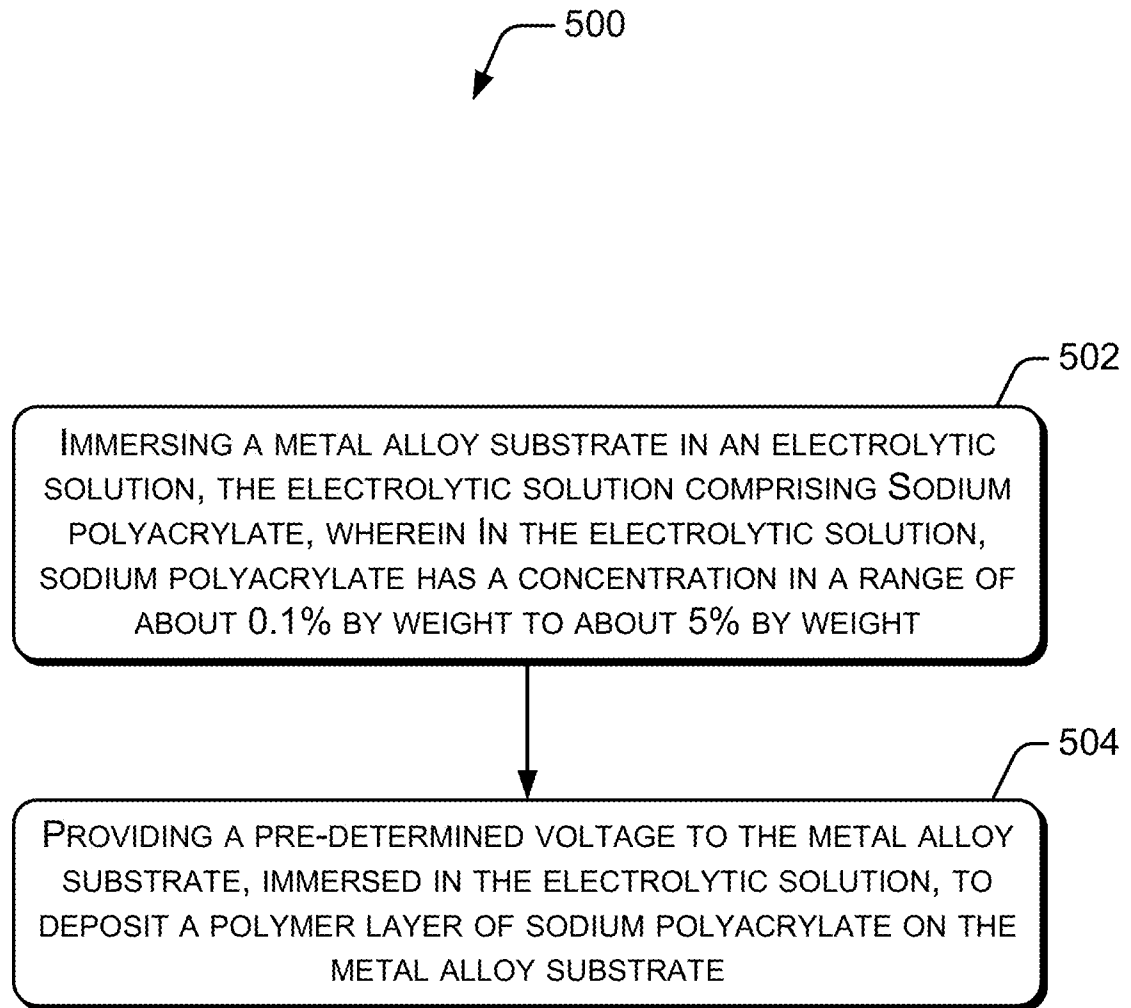


FIG. 5

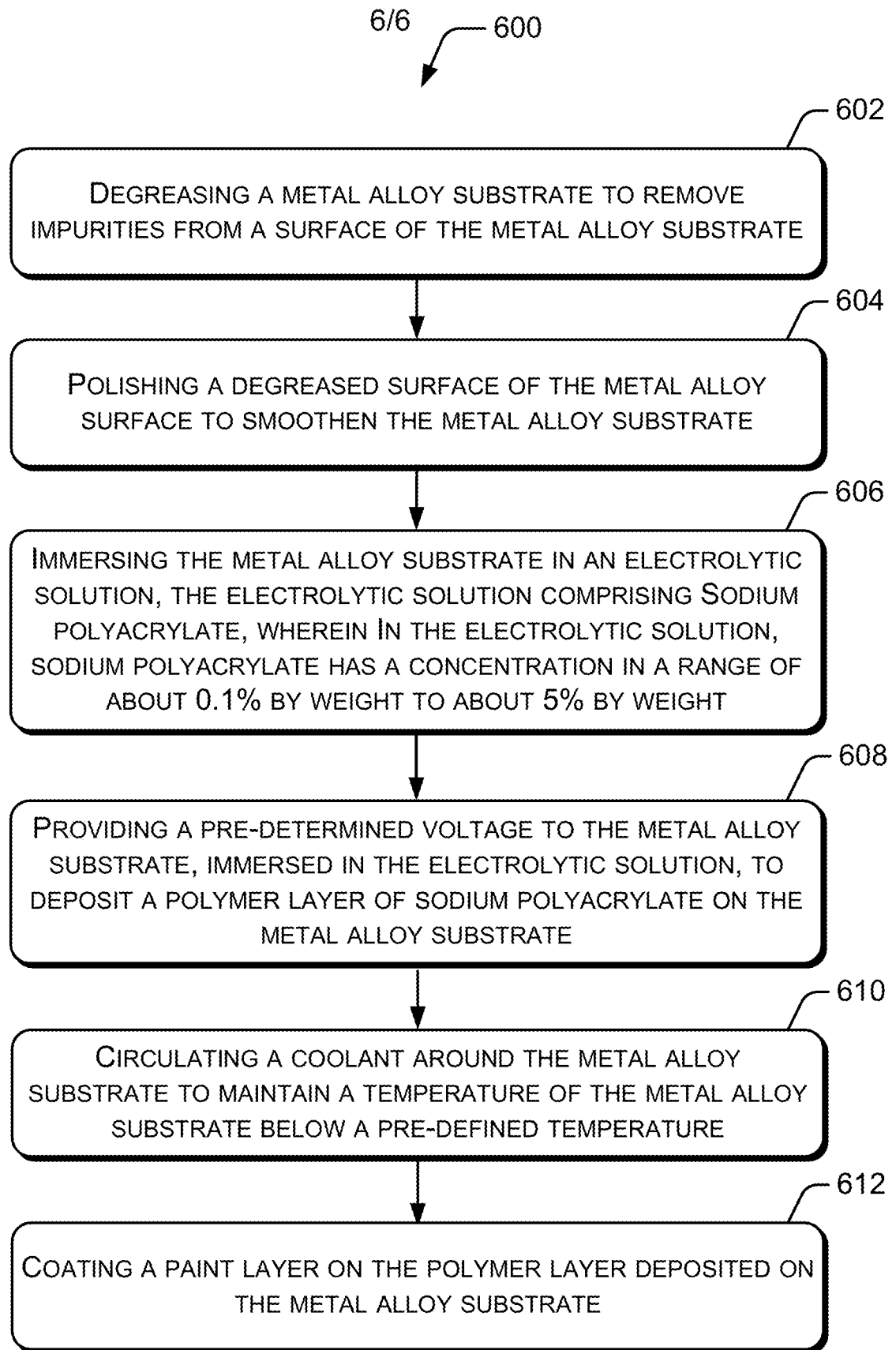


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2018/044012

A. CLASSIFICATION OF SUBJECT MATTER <i>C25D 9/02 (2006.01)</i>		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) C25D 9/00-9/12		
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, Espacenet, Information Retrieval System of FIPS		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4405427 A (MCDONNELL DOUGLAS CORPORATION) 20.09.1983, col. 6, lines 3-13, col. 7, 8, col. 9, lines 15-16, 35-37, abstract, examples	1-15
Y	US 5578869 A (OLIN CORPORATION) 26.11.1996, col. 2, lines 25-27, 33-41, claim 10	1-15
Y	WO 2016/163991 A1 (HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.) 13.10.2016, paragraphs [0019], [0021], [0024]	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	
15 March 2019 (15.03.2019)	18 April 2019 (18.04.2019)	
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 I. Eliseeva Telephone No. 8(495) 531-64-81	