DIGITAL NAIL SYSTEM WITH NAIL INSERTION SENSOR FOR ARTIFICIAL NAILS AND ASSOCIATED METHODS

Cross-Reference To Related Applications

[0001] The present application claims the benefit of U.S. Provisional Patent Application Ser. No. 63/658,016 filed June 10, 2024, all of which is fully incorporated by reference.

Technical Field

[0002] The present disclosure relates to artificial nails, and, more particularly, to a digital nail system for programming a color display in an artificial nail and associated methods.

Background

[0003] Nail polish is typically applied onto the nails of a person for decorative purpose. A number of items are generally needed by the person for this process. These items may include a nail polish container, a nail polish remover container, a top coat container, a base coat container, a nail polish remover pad, nail scissors, a nail clipper, a nail file, and so forth.

[0004] Furthermore, these items can become misplaced, which can be time consuming and/or expensive for the person to replace. Also, using some of the fluid-based items often results in noxious fumes, flammable conditions, and/or spillage onto the person’s belongings. Additionally, the nail polish frequently chips and fades within a short time period from application, thereby exposing the person's unpolished nail underneath.

Although the person can self-reapply the nail polish onto the nail, such self-reapplication may not be convenient when needed.

[0005] An alternative to applying polish is for the person to apply artificial nails instead, which results in the person having polished looking nails without requiring all of the above discussed items associated with using nail polish. However, a drawback of artificial nails is that the user is limited to the particular polish color or design on the artificial nails. For the person to change colors, a different set of artificial nails are needed.

[0006] One approach to overcome limitations of using pre-colored artificial nails is to use artificial nails with a color display that allows the person to change colors of the artificial nails. Artificial nails with color displays are disclosed in U.S. published patent application no. 2016/0295989. Such a system includes a nail covering device comprising a body configured to mate with a fingernail of a user, a display associated with an upper surface of the body, and a receiving unit for communicating with a design transfer device. The display uses electrophoretic ink to display designs. The system further includes a design transfer device comprising a housing that includes a processing unit and a memory unit for storing at least one design, wherein the design transfer device is configured to transmit the at least one design to the nail covering device. A server storing a plurality of designs is communicatively coupled with the design transfer device. A user causes the at least one design to be transferred from the server to the design transfer device using an application executing on a mobile device associated with the user.

[0007] Another approach for an artificial nail with a color display is disclosed in US patent no. 8,863,759. A cosmetic device is to be applied to an artificial nail, wherein the

device includes an electrochromic multilayer structure comprising an electrosensitive stack. The electrosensitive stack is formed by at least first and second electrode layers, with the first and second electrode layers being coatings supported by respective support layers. The support layers are formed by a single flexible film or an assembly of flexible films, first and second active electrochromic layers, and an electrolyte layer. The cosmetic device further includes an optically-active layer that is superposed, at least in part, on the electrosensitive stack. The optically-active layer is at least one of a layer including an effect pigment, a colored layer, a luminescent layer and printing.

[0008] Nonetheless, there is still a need to improve upon artificial nails with color displays and how to program the color displays.

Summary

[0009] A digital nail system includes a client device, a color programming device, and an artificial nail assembly. The client device may include a nail color app for providing color options for programming the artificial nail assembly. The color programming device may include contact pins and a nail insertion sensor, and is configured to communicate with the client device to receive at least one user-selected color option.

[0010] The artificial nail assembly may include a nail blank, and a color display coupled to an underside of the nail blank. The color display may include a first conductive layer, an electronic paper layer, and a backplane. The backplane may include a support layer, a second conductive layer on an upper surface of the support layer, a plurality of traces on an underside of the support layer, a plurality of vias extending between the plurality of traces and the first and second

conductive layers, and a bottom layer.

[0011] The bottom layer may include an electrical insulating section underlying a first portion of the plurality of traces, and a first portion of the support layer, and conductive interface pads underlying a second portion of the plurality of traces and a second portion of the support layer. The conductive interface pads are for contacting the contact pins in the color programming device after insertion of the artificial nail into an opening in the color programming device. Upon detecting insertion by the nail insertion sensor, the color programming device may be configured to generate programming signals to program the color display to the at least one user-selected color option.

[0012] The electronic paper layer may include an electrophoretic layer. The first conductive layer is transparent. The second conductive layer may include a plurality of spaced apart second conductive layer sections, with each second conductive layer section being separately controlled for configuring the electronic paper layer to display different colors.

[0013] The plurality of traces may include a first trace for the first conductive layer, and a plurality of second traces for the second conductive layer sections, and wherein the plurality of vias may include a first via extending between the first trace and the first conductive layer, and a plurality of second vias extending between the plurality of second traces and the plurality of second conductive layer sections.

[0014] The underside of the nail blank may be shaped as a simple curve for bonding with an upper surface of the display that is shaped as a simple curve, and wherein an upper surface of the nail blank is shaped as a compound curve.

[0015] The underside of the electrical insulating section may

be shaped as a simple curve, and the artificial nail assembly may further include a nail interface adapter having an upper surface shaped as a simple curve for bonding with the underside of the electrical insulating section, and an underside shaped as a compound curve for directly bonding with the user's nail.

[0016] Edges of the nail interface adapter and edges of the nail blank may be bonded together so that a load on the nail interface adapter is transferred to the nail blank and not to the color display.

[0017] An outer exposed surface of the nail blank may be etched to optically alter passage of light through the nail blank. In another embodiment, a subsurface of the nail blank may include micro air bubbles to optically alter passage of light through the nail blank.

[0018] The conductive interface pads may be spaced apart in a lengthwise direction of the support layer. In another embodiment, the conductive interface pads may be spaced apart in a widthwise direction of the support layer.

[0019] The color programming device may configured as a wand to include a housing, a wireless transceiver configured to communicate with the client device to receive a subset of color options, and a controller coupled to the wireless transceiver and the nail insertion sensor. A display is coupled to the controller, and may be configured to display the subset of color options. A user input is coupled to the controller, and may be configured to select at least one color options from the subset of color options in response to input by the user. Drive circuitry is coupled to the controller and the contact pins, and may be configured to generate the programming signals for programming the color display to the at least one user-selected color option in response to the nail insertion sensor sensing insertion of the artificial nail assembly into the opening in

the color programming device.

[0020] The color programming device may further include a temperature sensor to provide a temperature value to the controller. The programming signals may be generated based on the temperature value and at least one user-selected color option.

[0021] In another embodiment, the color programming device may be configured as a dongle that includes a connector to be connected to the client device. The dongle further includes a housing, and a controller coupled to the connector and to the nail insertion sensor. The controller is configured to receive from the client device the at least one user-selected color option. Drive circuitry is coupled to the controller and to the contact pins. The drive circuitry may be configured to generate the programming signals for programming the color display to the at least one user-selected color option in response to the nail insertion sensor sensing insertion of the artificial nail assembly into the opening in the color programming device.

[0022] The dongle may further include a temperature sensor coupled to the controller to provide a temperature value to the client device. The programming signals may be generated based on the temperature value and the at least one user-selected color option.

[0023] Another aspect is directed to a method for operating the color programming device configured as a wand, as described above.

[0024] Yet another aspect is directed to a method for operating the color programming device configured as a dongle as described above.

Brief Description of the Drawings

[0025] FIG. 1 is a schematic diagram of a digital nail system

in which various aspects of the disclosure may be implemented.

[0026] FIG. 2A is a top view of the support layer illustrated in FIG. 1 with a second conductive layer deposited thereon for a single-color display.

[0027] FIG. 2B is bottom view of the support layer illustrated in FIG. 2A with the traces deposited thereon.

[0028] FIG. 2C is bottom view of the support layer illustrated in FIG. 2B with the electrical insulating section and the conductive interface pads deposited thereon.

[0029] FIG. 3A is a top view of the support layer illustrated in FIG. 1 with the second conductive layer deposited thereon in sections for a multi-color display.

[0030] FIG. 3B is bottom view of the support layer illustrated in FIG. 3A with the traces deposited thereon.

[0031] FIG. 3C is bottom view of the support layer illustrated in FIG. 2B with the electrical insulating section and the conductive interface pads deposited thereon.

[0032] FIG. 4 is a top view of the support layer illustrated in FIG. 1 with the second conductive layer deposited thereon and with tails extending from the support layer.

[0033] FIG. 5 is bottom view of the support layer illustrated in FIG. 1 with the conductive interface pads each extending across a width of the support layer.

[0034] FIGS. 6A-6C are different views of the artificial nail assembly illustrated in FIG. 1.

[0035] FIG. 7 is an exploded front view of the nail blank, the color display and the nail interface adapter illustrated in FIG. 1.

[0036] FIGS. 8A-8B are different views of the nail blank illustrated in FIG. 1 with surface modifications formed therein.

[0037] FIGS. 9A-9B are different views of the nail blank illustrated in FIG. 1 with micro air bubbles formed in a

subsurface thereof.

[0038] FIG. 10A is a block diagram of one embodiment of the color programming device illustrated in FIG. 1

[0039] FIG. 10B is an isometric view of the color programming device illustrated in FIG. 10A interfacing with an artificial nail assembly.

[0040] FIG. 11A is a partial cross-sectional side view of the nail insertion sensor illustrated in FIG. 10A.

[0041] FIG. 11B is partial cross-sectional side view of the nail insertion sensor illustrated in FIG. 11A interfacing with the artificial nail assembly.

[0042] FIG. 12A is a partial cross-sectional front view of the color programming device illustrated in FIG. 10A with vertical alignment guides for guiding the artificial nail assembly in a vertical direction.

[0043] FIGS. 12B-12C are partial cross-sectional top views of the color programming device illustrated in FIG. 10A with horizontal alignment guides for guiding the artificial nail assembly in a horizontal direction.

[0044] FIGS. 13A-13E are different views of another embodiment of the nail position pivot arm integrated with the alignment guides illustrated in FIGS. 12A-12C.

[0045] FIG. 14A is a block diagram of another embodiment of the color programming device illustrated in FIG. 1

[0046] FIG. 14B is a perspective view of the color programming device illustrated in FIG. 14A interfacing with an artificial nail assembly.

[0047] FIGS. 15A-15B are screenshots of the nail polish app on the client device illustrated in FIG. 1.

[0048] FIG. 16 is a flowchart for operating the color programming device configured as a wand as illustrated in FIG. 10A.

[0049] FIG. 17 is a flowchart for operating the color programming device configured as a dongle as illustrated in FIG. 14A.

Detailed Description

[0050] The present description is made with reference to the accompanying drawings, in which exemplary embodiments are shown. However, many different embodiments may be used, and thus the description should not be construed as limited to the particular embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete. Like numbers refer to like elements throughout, and prime and double prime notations may be used to indicate similar elements in different embodiments.

[0051] Referring initially to FIG. 1, a digital nail system **20** includes a client device **30**, a color programming device **40** and an artificial nail assembly **60** with a color display **62** bonded to an underside of a nail blank **92**. The color display **62** is programmable for displaying one or more user-selected colors. The artificial nail assembly **60** is to be bonded to a nail of a user, which may be a fingernail or a toenail.

[0052] The client device **30** may be a desktop computing device or a mobile computing device. A mobile computing device includes a cell phone or a personal display assistant (PDA), for example.

[0053] The color programming device **40** may be configured as a wand or as a dongle, and includes a nail insertion sensor **49** to sense when the artificial nail assembly **60** has been inserted into the color programming device **40**.In response to the nail insertion sensor **49** sensing that the artificial nail assembly **60** has been inserted, programming signals are generated by the color programming device **40** to program the color display **62** to at least one user-selected color option **44**.

[0054] The nail insertion sensor **49** may be a touch sensor, for example, which operates when an object gets in physical contact with the touch sensor. The touch sensor may also be called a tactile sensor and is sensitive to touch, force or pressure. A touch sensor can be implemented using capacitive or resistive sensing technology. In other configurations, the nail insertion sensor **49** may be a beam interruption sensor, for example. A beam interruption sensor includes light sensors, ultrasonic sensors, magnetic field interruption sensors, etc.

[0055] The wand configuration wirelessly interfaces with the client device **30** for programming the color display **62**, whereas the dongle configuration is directly coupled to the client device for programming the color display **62**. The dongle configuration is considerably smaller in size since many of the components in the wand are now performed by the client device **30**.

[0056] Even though the digital nail system **20** is directed to artificial nails, the system may be equally adapted to cosmetic jewelry. The same color display **62** configuration as will be discussed in detail below may be applied to necklaces, pendants, bracelets and more while using the same client device **30** and color programming device **40** for programming. In addition, the cosmetic jewelry may also include body piercing adornments, such as ear hole loops or disks, for example.

[0057] The client device **30** includes a nail color app **32** that is configured to display a set of color options **34** available for the color display **62**. Each color option **34** has at least one corresponding color file **36** associated therewith, with each color file **36** providing programming signal values to be used in generating the programing signals needed to program the color display **62**. The programming signal values may be voltage levels, for example.

[0058] The color programming device **40** includes a plurality of contact pins **48**, and is configured to communicate with the client device **30**. The color programming device **40** is to receive at least one user-selected color option **44** and at least one corresponding color file **46**, and to generate programming signals based on the programming signal values provided by the at least one color file.

[0059] To program the color display **62**, the plurality of contact pins **48** make contact with a plurality of conductive interface pads **88** in the artificial nail assembly **60**. This allows the color display **62** to receive the generated programming voltages so as to be programmed to display the at least one user-selected color option.

[0060] As will be explained in more detail below, the artificial nail assembly **60** is inserted into the color programming device **40** after the user has selected one of the color options **44** for the color display **62**. Programming of the color display **62** is initiated in response to the nail insertion sensor **49** sensing insertion of the artificial nail assembly **60** into the color programming device **40**. If the artificial nail assembly **60** has been inserted into the color programming device **40** before a color option **44** has been selected, then the color display **62** is programmed with a default color option or with the last color option that was selected by the user.

[0061] The color display **62** for the artificial nail assembly **60** includes a first conductive layer **70** that may also be referred to as a first electrode, an electronic paper layer **72** and a backplane **66**. A transparent protective layer **90** covers the first conductive layer **70**. The protective layer **90** is a thermoplastic polymer, such as polyethylene terephthalate (PET). The first conductive layer **70** is a transparent electrically conductive material, such as indium tin oxide (ITO).

[0062] In one embodiment, the electronic paper layer **72** is an electrophoretic layer. In other embodiments, the electronic paper layer **72** may be an electrochromic layer, for example. For discussion purposes of the color display **62**, the electronic paper layer **72** is configured as the electrophoretic layer.

[0063] Electronic paper is a technology that replicates the appearance of ordinary ink on paper. It works by using tiny capsules filled with clear fluid containing minuscule particles, each about the width of a human hair. These capsules are arranged in a thin film with particles of different colors and electric charges. The electric charges are initially set at the factory so that the capsules remain in a charged state. When an electric field is applied to the individual electrodes, i.e., first and second conductive layers **70** and **76**, the particles move within the charged capsules, causing the electronic paper layer **72** to appear as a certain color.

[0064] The electronic paper layer **72** is bistable, meaning it retains a static image even without electricity, and it is reflective, reflecting ambient light rather than emitting its own. Because of these properties, electronic paper is energy-efficient and can display content without constant refreshing, making it ideal for artificial nails.

[0065] The backplane **66** may also be referred to as a custom backplane and is configured so that the color display **62** is functional within the artificial nail assembly **60** and can be programmed via the color programming device **40**. The backplane **66** includes a support layer **74**, a second conductive layer **76** on an upper surface of the support layer **74**, and a plurality of traces **78**, **79** on an underside of the support layer **74**. The second conductive layer **76** may also be referred to as a second electrode. The support layer **74** may be a thermoplastic polymer.

[0066] The second conductive layer **76** is an electrically

conductive material, and does not need to be transparent. Example electrically conductive materials are carbon, copper, silver and gold. As will be discussed in detail below, the second conductive layer **76** may be split into sections, with each section being separately controlled for configuring the electronic paper layer **72** to appear as different colors. The traces **78, 79** are also an electrically conductive material, such as silver. The second conductive layer **76** and the traces **78, 79** are printed on opposing sides of the support layer **74.**

[0067] The backplane **66** further includes a plurality of vias **80, 82** extending between the plurality of traces **78, 79** and the first and second conductive layers **70, 76.** Via **80** extends between a first one of the traces **78** and the first conductive layer **70.** Via **82** extends between a second one of the traces **79** and the second conductive layer **76.**

[0068] The backplane **66** further includes a bottom layer **84** comprising an electrical insulating section **86** and a plurality of conductive interface pads **88** formed on an underside of the support layer **74.** The electrical insulating section **86** is a dielectric material since an underside of the electrical insulating section is to be coupled to a nail of the user. The plurality of conductive interface pads **88** may be carbon, for example, and interface with the first and second traces **78, 79.**

[0069] In particular, the electrical insulating section **86** underlies the plurality of vias **80** and **82,** a first portion of the first and second traces **78, 79** and a first portion of the support layer **74.** Similarly, the plurality of conductive interface pads **88** underlie a second portion of the first and second traces **78, 79** and a second portion of the support layer **74.**

[0070] A first one of the conductive interface pads **88** contacts the first trace **78,** and a second one of the conductive

interface pads **88** contacts the second trace **79**. The first conductive interface pad **88** may be referred to as conductive interface pad **88(1)**, and the second conductive interface pad **88** may be referred to as conductive interface pad **88(2)**. The first and second conductive interface pads **88(1)**, **88(2)** make electrical contact with the contact pins **48** in the color program device **40** when the color display **62** is to be programmed to display a selected color option **44**.

[0071] Referring now to FIGS. 2A-2C, the opposing top and bottom sides of the support layer **74** will be discussed for the color display **62** configured as a single-color display. The top side of the support layer **74** has the second conductive layer **76** printed thereon as a continuous section, as shown in FIG. 2A. Likewise, the first conductive layer **70** is also printed as a continuous sheet.

[0072] A small area of the support layer **74** is not covered by the second conductive layer **76** so as to allow via **80** to pass through without making contact with the second conductive layer **76**. The bottom side of the support layer **74** has the first trace **78** and the second trace **79** printed thereon, as shown in FIG. 2B. Via **80** extends from the first trace **78** to the first conductive layer **70**, and via **82** extends from the second trace **79** to the second conductive layer **76**.

[0073] The electrical insulating section **86** is formed to cover a first portion of the traces **78**, **79** that make contact with the vias **80**, **82**, and a first portion of the exposed support layer **74**, as shown in FIG. 2C. Similarly, the plurality of conductive interface pads **88** are formed to cover a second portion of the first and second traces **78**, **79** and a second portion of the exposed support layer **74**.

[0074] The plurality of conductive interface pads **88** may be referred to as first conductive interface pad **88(1)** and second

conductive interface pad **88(2)**. The first and second conductive interface pads **88(1)**, **88(2)** help to protect the first and second traces **78**, **79** and to provide a broader interface area for contact pins carried by the color programming device **40**. The first and second conductive interface pads **88(1)**, **88(2)** are electrically separated by a gap **89**.

[0075] The first conductive interface pad **88(1)** allows the color programming device **40** to make electrical contact with the first conductive layer **70**, i.e., first electrode. Similarly, the second conductive interface pad **88(2)** allows the color programming device **40** to make electrical contact with the second conductive layer **76**, i.e., second electrode. When a differential in voltage is applied to the first and second electrodes **70**, **76**, the capsules in the electronic paper layer **72** are all set to the same color. The electronic paper layer **72** appears as a single pixel. As an example, the differential in voltage may be based on ground being applied to the first electrode **70** and 24 volts being applied to the second electrode **76**.

[0076] Referring now to FIGS. 3A-3C, the opposing top and bottom sides of the support layer **74** will be discussed for the color display **62** configured as a multi-color display. This requires the first conductive layer **70** or the second conductive layer **76** to be divided into sections, where each section is electrically separated from the other sections and can be separately controlled with a different voltage level. As an example, the second conductive layer **76** may be divided into second conductive layer sections **76(1)**, **76(2)** for a French tip nail design, as shown in FIG. 3A. A gap **77** electrically separates the second conductive layer sections **76(1)**, **76(2)**.

[0077] Since there are now two second conductive layer sections **76(1)**, **76(2)**, an extra trace and via are needed, as shown in FIG. 3B. The first trace **78** still interfaces with the

first conductive layer **70** using via **80**. The second trace **79** is now separated into second traces **79(1)** and **79(2)**. Second trace **79(1)** is to connect with second conductive layer section **76(1)** using via **82(1)**, and second trace **79(2)** is to connect with the second conductive layer section **76(2)** using via **82(2)**.

[0078] An advantage of switching the color display **66** at the second conductive layer sections **76(1)**, **76(2)** is that there will be less interruptions in the color display **62** since only one contact (i.e., via **80**) is required for the first conductive layer **70** formed as a single continuous layer. Dividing the first conductive layer **70** into sections would require multiple contacts, and since the first conductive layer **70** is transparent, this would lead to more interruptions in the color display **62**. In contrast, the contacts for the second conductive layer sections **76(1)**, **76(2)** are not visible.

[0079] The electrical insulating section **86** is formed to cover a first portion of the first and second traces **78**, **79(1)**, **79(2)** that make contact with vias **80**, **82(1)**, **82(2)** and a first portion of the exposed support layer **74**, as shown in FIG. 3C. The first and second traces **78**, **79(1)**, **79(2)** each require its own conductive interface pad, as also shown in FIG. 3C. Accordingly, conductive interface pad **88(1)** is for first trace **78**, conductive interface pad **88(2)** is for second trace **79(1)**, and conductive interface pad **88(3)** is for second trace **79(2)**. Gaps **89** separate adjacent conductive interface pads **88(1)**, **88(2)** and **88(3)**.

[0080] The first conductive interface pad **88(1)** allows a respective contact pin **48** in the color programming device **40** to make electrical contact with the first conductive layer **70**. Similarly, second conductive interface pad **88(2)** allows a respective contact pin **48** in the color programming device **40** to make electrical contact with the second conductive layer section

76(1), and second conductive interface pad **88(3)** allows a respective contact pin **48** in the color programming device **40** to make electrical contact with the second conductive layer section **76(2)**.

[0081] The second conductive layer sections **76(1)**, **76(2)** are separately controlled second electrodes. When a differential in voltage is applied to the first electrode **70** and the second electrode **76(1)**, the respective capsules in the electronic paper layer **72** between the first and second electrodes **70**, **76(1)** are all set to the same first color. When a different differential in voltage is applied to the first electrode **70** and the second electrode **76(2)**, the respective capsules in the electronic paper layer **72** between the first and second electrodes **70**, **76(2)** are all set to the same second color that is different from the first color.

[0082] For the color display **66** to display more than the first and second colors, the second conductive layer would be further divided into more than two second conductive layer sections. Each second conductive layer section would require its own trace, via and conductive interface pad. As readily appreciated by those skilled in the art, each second conductive layer section may be shaped so that a desired pattern, symbol, design or alpha-numeric value is displayed.

[0083] Referring now to FIG. 4, an alternative design for the second conductive layer **76** and the first and second traces **78**, **79** is based on configuring the second conductive layer **76'** with tails **78'**, **79'**. Tail **78'** functions as first trace **78**, and tail **79'** functions as second trace **79**. The tails **78'**, **79'** are flexible so that they can be folded from the top side to the bottom side of the second conductive layer **76'**.

[0084] The tails **78'**, **79'** may be printed separate from the second conductive layer **76'** and then placed on a top side of the

support layer **74'** to be folded. Alternatively, the tails **78'**, **79'** may be printed at the same time as the second conductive layer **76'** so that tail **79'** is an extension of the second conductive layer **76'**.

[0085] Tail **79'** is in electrical contact with the second conductive layer **76'**. This advantageously avoids the need for via **82** since an electrical connection exists between the second conductive layer **76'** and the tail **79'**. Since tail **78'** is to connect with via **80'**, the tail **78'** is electrically separated from the second conductive layer **76'**. Via **80'** extends between the first conductive layer **70** and the top side of the support layer **74'**. Connection of the via **80'** to the bottom side of the support layer **74'** is not needed since tail **78'** is folded from the top side to the bottom side of the second conductive layer **76'**.

[0086] Referring now to FIG. 5, an alternate design on an underside of the support layer **74'** has the conductive interface pads **88(1)'**, **88(2)'** stacked in a lengthwise direction of the support layer **74**. Each conductive interface pad **88(1)'**, **88(2)'** extends across a width of the support layer **74'**. This allows the contact pins **48** in the color programming device **40** to also be stacked in a lengthwise direction of the support layer **74**.

[0087] The first and second traces **78**, **79** are configured such that they make contact with the conductive interface pads **88(1)'**, **88(2)'**. This requires one of the traces to extend across both of the conductive interface pads **88(1)'**, **88(2)'**. A dielectric layer is used so that this trace does not electrically contact conductive interface pad **88(2)'** when contacting conductive interface pad **88(1)'**.

[0088] The distance between a tip of the artificial nail assembly **60** and the user's finger is relatively consistent between different size artificial nail assemblies **60**. When an

artificial nail assembly **60** is to be programmed, the tip of an artificial nail assembly **60** makes contact with a hard stop in the color programming device **40**. For smaller size artificial nail assemblies **60**, such as for a user's pinky nail, this allows more lead way for the stacked contact pins **48** in the color programming device **40** to make contact with the stacked conductive interface pads **88(1)', 88(2)'**

[0089] Referring now to FIGS. 6A-6C, different views of the artificial nail assembly **60** are provided. The human nail has curvature in both the axis of the finger as well as the axis perpendicular to the finger. That is, an upper surface of the human nail has a complex curve shape since there are two axis of curvature. Consequently, an upper surface **93** of the nail blank **92** has a complex curve shape to aesthetically look like a natural nail.

[0090] However, there are physical limitations imposed by the mechanical layout of the color display **62** and/or its material makeup. These limitations may restrict or otherwise dictate how best the various layers can be curved or flexed to interface with the underside of the nail blank **92**. Physical limitations may dictate the color display **62** to have a less than desired complex curve shape due to mechanical stresses inducing strain on the electronic paper layer **72** which could negatively affect performance of the color display **62**. In other words, there are physical limitations on how much the color display **62** can be curved or flexed to interface with the underside of the nail blank **92**. The color display **62** is preferably curved to have a conformal curve shape instead of a complex curve shape.

[0091] As best shown in FIG. 7, an upper surface **67** and a lower surface **68** of the color display **62** are curved about a single axis. That is, the upper and lower surfaces **67, 68** of the color display **62** each have a single axis of curvature. For the

nail blank **92** to interface with the upper surface **68** of the color display **62**, a bottom surface **95** of the nail blank **92** is formed to have single axis of curvature.

[0092] For the lower surface **67** of the color display **62** to bond securely to the upper surface of the human nail, a nail interface adapter **94** is provided. A lower surface **97** of the nail interface adapter **94** has a complex curve shape to securely interface with the user's nail, and an upper surface **99** of the nail interface adapter **94** has a simple curve shape to interface with the lower surface **67** of the color display **62**.

[0093] The nail blank **92** may be formed with injection molding. The 3D curvature of the artificial nail assembly **60** is achieved with a physical surface-to-surface bonding of the color display **62** to a precast thermosetting polymer. The precast thermosetting polymer may be a polymer nail blank **92**, such as an acrylic nail blank, for example. Bonding of the color display **62** to the polymer nail blank **92** is done with an optically clear adhesive creating a bonded optical system. The bonded optical system is attached to a user's nail using a precast nail interface adapter **94**, wherein an adhesive is used to secure the nail interface adapter **94** to the user's nail.

[0094] The artificial nail assembly **60** may be between 5 and 10 mils in stack thickness, consisting of a 3 to 5 mil thick color display **62** element, a 1 mil bond layer, and a 1 to 5 mil thick polymer over-element nail blank **92**. Casting equipment used for the nail blank **92** may be hot pressed from sheet polymer, blow molded, cast separate or fusion cast directly to the color display **62**.

[0095] A surface of the nail blank **92** may be modified to adjust the various parameters to enhance the underlying color of the artificial nail assembly **60**, altering its prismatic visual effect, amplifying desired optical effects or minimizing

undesired optical effects. One example of surface modification is laser ablation surface modification, where an outer exposed surface **93** of the nail blank **92** or the final artificial nail assembly **60** is etched to optically alter passage of light through the nail blank **92**. As an example, lines **100** having a triangular shape may be etched into the upper surface **93** of the nail blank **92**, as shown in FIGS. 8A-8B.

[0096] The uppermost surface **93** of the nail blank **92** may be a pre-formed polymer shell that can be modified via laser energy surface ablation so that fine lines, curves or patterns of geometrical figures may be etched into the uppermost surface **93**. The volume of material that makes up the etching is effectively removed to establish a lower surface topography along the length of the nail blank **92**, or in any repeating pattern that is required to effect the optical result desired. The illustrated instance of chromatic enhancement is based on repeating parallel lines running the length of the nail blank **92** from rear to tip.

[0097] The underlying physics that allows for the optical alteration of the uppermost surface **93** and effect on the underlying color is the establishment of constructive and or destructive interference patterns across the nail assembly surface that alter the passage of light through the outer protective shell of the artificial nail assembly **60**. To achieve a specific optical outcome, certain ablation characteristics may be varied.

[0098] Ablation characteristics include the base material, ablation depth, width, ablation profile, energy frequency, ablation rate, base material surface roughness, ablated surface roughness, pattern, pattern width, optical properties of polymer overcoat, thermal distortion characteristics of the base material and the wavelength of the underlying color to be

optimized. Once the processing parameters of the ablation are established, the physical pattern is burned onto one or more of the surfaces of the pre-formed polymer nail blank **92** and or the external surface of the final artificial nail assembly **60**. A mismatch in the refractive indexes of the various optical components and bonding adhesives are utilized to generate optical distortions that enhance the overall color experience.

[0099] Another instance of surface modification via laser ablation is the creation of micro bubbles within the nail shell for the purposes of prismatic optical alteration. A subsurface **102** of the nail blank **92** is altered using dual lasers to create micro air bubbles **104** to optically alter passage of light through the nail blank **92**, as shown in FIGS. 9A-9B. A mismatch in the refractive indexes of the various optical components and bonding adhesives are utilized to generate optical distortions that enhance the overall color experience.

[00100] Laser ablation surface modification can adjust the various parameters to enhance the prismatic effect of patterned micro air bubbles **104** formed within the polymer shell of the nail blank **92**. Selective bouncing of light rays within patterned micro air bubbles **104** can produce desired optical effects on the final artificial nail assembly **60**. The pre-formed polymer nail blank **92** or shell can be modified via laser energy cavity ablation so that micro air bubbles **104** are formed in the volume of the nail blank **92** for the effect of light ray scattering. The formation of micro air bubbles **104** in the material will induce physical stress in the optical material inducing a host of prismatic optical ray scatterings including polarization, chromatic aberration, internal cavity reflection and absorption. Careful placement of the micro bubble patterns can effect the optical result desired. This instance of chromatic enhancement is based on micro cavity ablation and void creation

within the nail shell material.

[00101] The underlying physics that allows for the optical alteration of the volume of the nail blank **92** and underlying color expression is the redirection of incident light rays into unique and contrast enhancing patterns within the transparent surfaces of the nail blank **92**. Light rays that would normally enter the nail assembly surface, penetrate to the color layer, reflect off the color layer, transverse the polymer shell and exit the upper most surface of the nail surface will now have to interact with micro voids in the transparent material that have irregular internal reflective surfaces, variable indexes of refraction, polarization and optical absorption properties.

[00102] To achieve a specific optical outcome, the ablation characteristics of the base material, micro cavity generation characteristic, cavity depth, cavity width, energy frequency, cavity volume rate, base material surface roughness, ablated surface roughness, pattern, optical properties of base material, thermal distortion characteristics of the base material and the refractive index of the base material and ablated surface may be varied. Once the processing parameters of the micro cavity ablation creation are established, the physical pattern is burned onto the transparent volume of the pre-formed polymer nail blank **92** and or the final artificial nail assembly **60**.

[00103] Referring now to FIGS. 10A-10B, the color programming device **40** will be discussed. The color programming device **40** may also be referred to as a wand and includes a housing **200**, and a wireless transceiver **210** carried by the housing **200**. The wireless transceiver **210** is configured to communicate with the client device **30** to receive a subset of color options **206** and a corresponding subset of color files **208**, wherein the subset of color files **208** provide programming signal values. The programming signal values may be voltage levels, for example.

The wireless transceiver **210** may operate based on short-range wireless technology, such as Bluetooth.

[00104] The user of the client device **30** interfaces with the nail color app **32** to select and transfer the subset of color options **206** and the corresponding subset of color files **208** to the color programming device **40**. The subset of color options **206** and the corresponding subset of color files **208** are stored in memory **204**.

[00105] A user input **212** is coupled to the controller **202**. The user input **212** may be a capacitive touch button, for example. The user input **212** allows the user to sequentially view the respective colors that are available in the subset of color options **206**. The respective colors are displayed on a color display **218** coupled to the controller **202**.

[00106] All of the available color options **34** viewed on the nail color app **32** may be transferred to the color programming device **40**. However, it would likely take the user a considerable amount of time to sequentially view each color option **34** on the display **218**. By the user selecting and transferring at the client device **30** a subset of color options **206** that are of interest, the user is able to more quickly view the subset of color options **206** for making a selection.

[00107] A nail display drive circuit **214** is coupled to the controller **202** and to the contact pins **48**. A nail insertion sensor **49** is coupled to the controller **202**. The nail insertion sensor **49** sensing when the artificial nail assembly **60** has been inserted into the color programming device polymer **40**. After the user selects one of the available color options **206**, the artificial nail assembly **60** is inserted into the color programming device polymer **40**. In response to the nail insertion sensor **49** sensing insertion of the artificial nail assembly **60**, the controller **202** causes the nail display drive circuit **214** to

generate the programming signals corresponding to the programming signal values in the color file **208** associated with the selected color option **206**.

[00108] Each microcapsule in the electronic paper layer **72** may include red, green and yellow (RGY) pigments as a color set of pigments. Another possible color set of pigments is magenta, cyan and yellow. The programming signal values in the color file **208** provides the voltage potential that is to be applied to the color display **62**, and for how long the voltage potential is to be applied. The voltage potential may be applied to the color display **62** in one time cycle or may be applied over a number of time cycles. A time cycle may last from a microsecond range to a longer millisecond range.

[00109] To program the color display **62** in the artificial nail assembly **60**, the user inserts the artificial nail assembly **60** into a slot or opening **230** in a side of the housing **200**. The artificial nail assembly **60** is inserted into the slot **230** until a hard stop is hit. This allows the conductive interface pads **88** in the artificial nail assembly **60** to align with the contact pins **48** in the color programming device **40**. The contact pins **48** are recessed from the slot **230** in a side of the housing **200**. The nail insertion sensor **49** senses insertion of the artificial nail assembly **60** into the slot **230**, and sends a signal to the controller **202**. The controller **202** causes the nail display driving circuit **214** to generate the programming signals which are applied to the color display **62** in the artificial nail assembly **60** while the artificial nail assembly **60** is inserted into the color programming device **40**.

[00110] The nail insertion sensor **49** will be discussed in reference to FIGS. 11A-12C. The nail insertion sensor **49** includes a nail position pivot arm **240** aligned with the opening **230** in the side of the housing **200**. The nail position pivot arm

240 is pivotable between a first position and a second position. The first position corresponds to the opening 230 being void of the artificial nail assembly 60 as shown in FIG. 11A. The second position corresponds to insertion of the artificial nail assembly 60 into the opening 230 as shown in FIG. 11B.

[00111] The nail insertion sensor 49 includes a nail position switch 238 carried by a printed circuit board 236. The nail position switch 238 is coupled to the controller 202 via traces in the printed circuit board 236. The nail position switch 238 is in an inactive position when the nail position pivot arm 240 is in the first position, and is in an active position when the nail position pivot arm 240 is in the second position. The second position functions as an interrupt to the controller 202. In response to an interrupt, the controller 202 communicates with the nail display driving circuit 214 for programming signals to be generated for the artificial nail assembly 60.

[00112] The nail position pivot arm 240 includes a lower pivot arm section 242 and an upper pivot arm section 244. The lower pivot arm section 242 makes contact with the nail position switch 238, and the upper pivot arm section 244 makes contact with an underside of the housing 200.

[00113] The nail position pivot arm 240 may be formed out of plastic which allows the upper pivot arm section 244 to be flexible so as to function as a spring that is biasing the lower pivot arm section 242 to make contact with the nail position switch 238. When the artificial nail assembly 60 makes contact with the nail position pivot arm 240, this causes the nail position pivot arm 240 to pivot.

[00114] An underside of the nail position pivot arm 240 may be sloped upwards so that as the artificial nail assembly 60 is inserted into the opening 230, the nail position pivot arm 240 pivots or is pushed upwards. The lower pivot arm section 242

then moves in an upward direction while the upper pivot arm section **244** is compressed against the underside of the housing **200**. This allows the nail position switch **238** to move from an inactive state to an active state.

[00115] In the active state, the artificial nail assembly **60** is fully inserted within the opening **238** so that the conductive interface pads **88** on the underside of the artificial nail assembly **60** make electrical contact with the contact pins **48**. Even though only one contact pin **48** is shown, there is a respective contact pin **49** for each conductive interface pad **88** on the underside of the artificial nail assembly **60**.

[00116] The opening **238** in the side of the housing **200** has a curved shape **231** to guide the artificial nail assembly **60** towards a center of the opening, as shown in FIG. 12A. This is particularly helpful for a smaller size artificial nail assembly **60**. The curved shape **231** matches an underside of the artificial nail assembly **60**. The housing **200** may include one or more vertical alignment guides **250** that push downwards to align the artificial nail assembly **60** in a vertical direction upon insertion within the opening **238**.

[00117] The housing **200** may also include a pair of horizontal alignment guides **252** that push inwards to align the artificial nail assembly **60** in a horizontal direction upon insertion within the opening **238**, as shown in FIGS. 12B-12C. The horizontal alignment guides **252** are flexible, and are biased towards one another. As the artificial nail assembly **60** is inserted into the opening **238**, the artificial nail assembly **60** causes the horizontal alignment guides **252** to move outwards in the horizontal direction. This is particularly helpful to accommodate larger size artificial nail assemblies **60**.

[00118] Referring now to FIGS. 13A-13E, another embodiment of the nail position pivot arm **240'** will be discussed. In this

embodiment, the nail position pivot arm **240'** and the horizontal alignment guides **252'** are configured as a monolithic unit. The monolithic unit may also be formed out of plastic.

[00119] The function of the vertical alignment guides is provided by the nail position pivot arm **240'** itself. That is, an underside of the nail position pivot arm **240'** that makes contact with the artificial nail assembly **60** is shaped to provide vertical alignment of the artificial nail assembly **60**. The horizontal alignment guides **252'** are flexible with curved surfaces. The shape of the curved surfaces is to accommodate different size artificial nail assemblies **60**.

[00120] The artificial nail assembly **60** may be inserted while the user is wearing the artificial nail assembly **60** or before the artificial nail assembly **60** is to be applied to the user's nail. After the color display **62** in the artificial nail assembly **60** has received the generated programming signals, the artificial nail assembly **60** is removed from the color programming device **40**.

[00121] At the time of the color setting, the electronic paper layer **72** in the color display **62** in the artificial nail assembly **60** may vary as a function of temperature. The color programming device **40** includes a temperature sensor **216** that provides a temperature value to the controller **202**. The controller **202** is configured to select the color file **208** corresponding to the temperature value. In other words, each respective color option **206** may have a number of color files **208** associated therewith. The programming signal values in the color files **208** for the respective color option **206** vary between different temperature values.

[00122] The color programming device **40** is powered by a battery **222**. A battery monitor **220** monitors a voltage level of the battery **222** and reports the voltage level to the controller

202. The controller 202 will display a status of the battery 222 in the color display 218 in the color programming device 40.

[00123] The color programming device 40 configured as a wand is the core technology driving the digital nail system 20. The wand 40 provides a non-disposable electronics package that provides a color display 218, a controller 202, a nail display driving circuit 214, a nail insertion sensor 49, a user input 212 and a wireless transceiver 210 to tie the digital nail system 20 together.

[00124] The wireless transceiver 210 may use a Bluetooth Low Energy protocol for communications and data transfer between the client device 30 and the wand 40. This is the means by which color information is transferred to the wand 40 for local storage of the selected colors. With increased color options, cycling through all colors if one is missed becomes increasingly frustrating. By limiting color options on the wand 40 locally, it improves user experience since the user input 212 configured as a capacitive touch interface cycles color choices in one direction.

[00125] The user interface for the wand 40 consists of the following items, including a single tap for color cycling and wand wakeup, and upon wake up from wand sleep, a rainbow animation may play on the color display 218 in the wand 40 followed by the battery status and the last color applied.

[00126] In addition to or in place of a long press of the capacitive touch button 212 to initiate programing of the color display 62 in the artificial nail assembly 60, the programming may be initiated in response to the nail insertion sensor 49 sensing insertion of the artificial nail assembly 60 into the wand 40. If the artificial nail assembly 60 has been inserted into the color programming device 40 before a color option 206 has been selected, then the color display 62 is programmed with

a default color option or with the last color option that was selected by the user.

[00127] To change colors, the artificial nail assembly **60** is inserted into the wand **40** through the insertion slot **230** to engage the internal electronics. The case design of the wand **40** provides a self-aligning port that guides the artificial nail assembly **60** into place to contact the electrical contact pins **48** in the wand **40.**

[00128] The mechanical portion of the wand **40** may use spring loaded pins connected to the nail display driving circuit **214** that interfaces with the isolated conductive interface pads **88** on the digital nail rear backplane. The nail insertion sensor **49** senses when the artificial nail assembly **60** has been inserted into the wand **40** and communicates this to the controller **202.** The controller **202** then instructs the nail display driving circuit **214** to generate the programming signals. The artificial nail assembly **60** remains engaged with the contact pins **48** while the color display **62** in the artificial nail assembly **60** is programmed to the user-selected color option **206.**

[00129] In addition, since the wand **40** is a self-contained device (microcontroller, wireless communications, real time clock, and storage), the wand **40** may be configured to time stamp all searching and modification information within the internal memory **204.** Once connected to the client device **30,** data is transferred to the nail color app **32** and the nail color app **32** populates an existing datalake. Sample data that can be gathered includes the following:

- Color chosen, date, time,
- GPS could be correlated after the fact with phone location data,
- Number of searches through the color options,

- Number of times the core color set on the wand was reprogrammed,
- Palette sharing, and
- Proximity to other app users (after the fact)

[00130] Referring now to FIGS. 14A-14B, another embodiment of the color programming device **40"** will be discussed. In this embodiment, the color programming device **40"** is configured as dongle that is to be directly coupled to a port in the client device **30**. The color programming device **40"** is considerably smaller in size since a number of color programming device **40"** functions as discussed above are performed by the client device **30** instead of by the color programming device **40"**.

[00131] The user is able to view the available color options **34** on a display of the client device **30** by interfacing with the nail color app **32** operating on the client device **30**. The color programing device **40"** includes a housing **200"**, and a connector **213"** that is coupled to the port on the client device **30**. The connector **213"** may extend outwards from the housing **200"** as shown in FIG. 14A.

[00132] Once the user selects a color option **34** using the client device **30**, the artificial nail assembly **60** is inserted into an opening **230"** in the color programming device **40"**. The nail insertion sensor **49"** senses insertion of the artificial nail assembly **60** into the dongle **40"** and sends a signal to the controller **202"**. The controller **202"** then instructs the display driving circuit **214"** to generate the programming signals which are applied to the color display **62** in the artificial nail assembly **60** while the artificial nail assembly **60** is inserted into the color programming device **40"**.

[00133] To program the color display **62** in the artificial nail assembly **60**, the user selects a color option **34** on the nail

color app **32** on the client device **30**. The artificial nail assembly **60** is inserted into the slot **230"** until a hard stop is hit. This allows the conductive interface pads **88** in the artificial nail assembly **60** to align with the contact pins **48'** in the color programming device **40"** The contact pins **48"** are recessed from the slot **230"** in a side of the housing **200"**. The nail insertion sensor **49"** senses insertion of the artificial nail assembly **60** into the dongle **40"**, and sends a signal to the controller **202"**. The controller **202"** causes the nail display driving circuit **214"** to generate the programming signals which are applied to the color display **62** in the artificial nail assembly **60** while the artificial nail assembly **60** is inserted into the color programming device **40"**.

[00134] The artificial nail assembly **60** may be inserted while the user is wearing the artificial nail assembly **60** or before the artificial nail assembly **60** is to be applied to the user's nail. After the color display **62** in the artificial nail assembly **60** has received the generated programming signals, the artificial nail assembly **60** is removed from the color programming device **40"**.

[00135] As noted above, the electronic paper layer **72** in the color display **62** in the artificial nail assembly **60** may vary as a function of temperature. The color programming device **40"** includes a temperature sensor **216"** that provides a temperature value to the client device **30**. This allows the client device **30** to select the color file **36** corresponding to the temperature value. In other words, each respective color option **34** may have a number of color files **36** associated therewith. The programming signal values in the color files **36** for the respective color option **206** vary between different temperature values. In other embodiments, the client device **30** has a temperature sensor.

[00136] Referring now to FIGS. 15A-15B, the nail polish app **32**

provides the critical control aspects that allow for the wand **40** to maintain a relatively straight forward user interface (UI). Within the nail polish app **32**, the user can interface several ways:

- Save the colors in customized palettes,
- Save colors to the wand transfer queue,
- Register the user,
- Register the product through the use of visual codes or wireless signals, and
- View wand battery status and estimated battery life

[00137] Two options are available for choosing colors. Option 1 is Customized Palettes, and option 2 is Wand Queue Colors. Customized Palettes may be shared within the nail polish app **32** socially with other users and others' customized palettes can be downloaded for use. Data is collected regarding color usage based on times and locations where possible. For the Wand Queue Colors, when the wand queue is ready for transfer, the nail polish app **32** connects to the wand **40** through Bluetooth and sends all pertinent information. This information includes the name of the colors chosen, RGB values for each color, appropriate waveform for a variety of temperatures to generate those colors, display type and serial number.

[00138] The nail polish app **32** also allows for control of the following items within the wand **40**, including LED color brightness, timeout values for LED offs, and timeout deep sleep mode.

[00139] An example screenshot **300** of the nail polish app **32** displays a number of different colors and color themes for the user to view and select. The colors may include trending colors **302**, curated palette colors **304**, what's your vibe? colors **306**,

and more palette colors **308**. As an example, the more palette colors **308** include pastel oasis **310** color and earth serenity colors **312**.

[00140] In order to select colors for the wand **40**, the user taps UI interface **314** to connect with the color programming device **40**. Once connected, the user is able to select a subset of color options **206**, which are displayed in prompt **316** in screenshot **320**. To transfer the subset of color options **206** to the wand **40**, the user selects prompt **318**.

[00141] The user then cycles through the subset of color options **206** on the wand **40** by pressing user input **212**. Once a color option **206** is selected, the artificial nail assembly **60** is inserted into the wand **40**. Programing of the color display **62** in the artificial nail assembly **60** is initiated in response to the nail insertion sensor **49** sensing that the artificial nail assembly **60** has been inserted into the wand **40**.

[00142] If the artificial nail assembly **60** has been inserted into the color programming device **40** before a color option **206** has been selected, then the color display **62** is programmed with a default color option or with the last color option that was selected by the user.

[00143] For the dongle **40”**, the color options displayed in prompt **316** are not sent to the dongle. Instead, the wand icon **318** may be replaced with an arrow icon to allow the user to cycle through the color options in prompt **316**. As the user cycles through the color options, each respective color option is highlighted one at a time. After the user selected color is highlighted, the artificial nail assembly **60** is inserted into the dongle **40”**.

[00144] Programing of the color display **62** in the artificial nail assembly **60** is initiated in response to the nail insertion sensor **49”** sensing that the artificial nail assembly **60** has been

inserted into the dongle **40”**. If the artificial nail assembly **60** has been inserted into the dongle **40”** before a color option **206** has been selected, then the color display **62** is programmed with a default color option or with the last color option that was selected by the user.

[00145] Another aspect is directed to a method for operating the color programming device **40** configured as a wand to program the color display **62** in the artificial nail assembly **60** as discussed above. Referring now to the flowchart **400** in FIG. 16, from the start (Block **402**), the method includes receiving wirelessly color options **44** from a nail color app **32** operating on a client device **30** at Block **404**, with the color options **44** including programming signal values **46**.

[00146] User input is received at Block **406** to cycle through the color options **44**. The artificial nail assembly **60** is inserted into the color programming device at Block **408** after selection of a color option **44**. The method includes at Block **410** sensing insertion of the artificial nail assembly **60** into the color programming device **40**. Programming signals corresponding to the programming signal values **46** are generated at Block **412** for the selected color option **44** to program the color display **62** in the artificial nail assembly **60** to the selected color option **44**. The artificial nail assembly **60** with the color display **62** programmed to the selected color option **44** is extracted from the color programming device **40** at Block **414**. The method ends at Block **416**.

[00147] Another aspect is directed to a method for operating the color programming device **40”** configured as a wand to program the color display **62** in the artificial nail assembly **60** as discussed above. Referring now to the flowchart **500** in FIG. 17, from the start (Block **502**), the method includes inserting at Block **504** the color programming device **40”** into a client device

30 with a nail color app 32.

[00148] A selected color option 44 that includes programming signal values 46 is received from the nail color app 32 at Block 506. An artificial nail assembly 60 is inserted into the color programming device 40" after selection of a color option 44 at Block 508. Insertion of the artificial nail assembly 60 into the color programming device 40" is sensed at Block 510. Programming signals corresponding to the programming signal values 46 for the selected color option 44 are generated at Block 512 to program the artificial nail assembly 60 to the selected color option 44. The artificial nail assembly 60 with the color display 62 programmed to the selected color option 44 is extracted at Block 514. The method ends at Block 516.

[00149] Many modifications and other embodiments will come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is understood that the foregoing is not to be limited to the example embodiments, and that modifications and other embodiments are intended to be included within the scope of the appended claims.

CLAIMS:

1. A digital nail system comprising:

a client device comprising a nail color app for providing color options;

a color programming device comprising a plurality of contact pins and a nail insertion sensor, and configured to communicate with the client device to receive at least one user-selected color option; and

an artificial nail assembly comprising:

a nail blank; and

a color display coupled to an underside of the nail blank and comprising a first conductive layer, an electronic paper layer and a backplane, the backplane comprising:

a support layer,

a second conductive layer on an upper surface of the support layer,

a plurality of traces on an underside of the support layer,

a plurality of vias extending between the plurality of traces and the first and second conductive layers, and

a bottom layer comprising:

an electrical insulating section underlying a first portion of the plurality of traces, and a first portion of the support layer, and

a plurality of conductive interface pads underlying a second portion of the plurality of traces and a second portion of the support layer, with the plurality of conductive interface pads for contacting the plurality of contact pins

after insertion into an opening in the color programming device;

the color programming device configured to generate programming signals to program the color display to the at least one user-selected color option in response to the nail insertion sensor sensing insertion of the artificial nail assembly into the opening in the color programming device.

2. The digital nail system according to claim 1 wherein the electronic paper layer comprises an electrophoretic layer.

3. The digital nail system according to claim 1 wherein the first conductive layer is transparent.

4. The digital nail system according to claim 1 wherein the second conductive layer comprises a plurality of spaced apart second conductive layer sections, with each second conductive layer section being separately controlled for configuring the electronic paper layer to display different colors.

5. The digital nail system according to claim 4 wherein the plurality of traces comprises a first trace for the first conductive layer, and a plurality of second traces for the second conductive layer sections, and wherein the plurality of vias comprises a first via extending between the first trace and the first conductive layer, and a plurality of second vias extending between the plurality of second traces and the plurality of second conductive layer sections.

6. The digital nail system according to claim 1 wherein the underside of the nail blank is shaped as a simple curve for

bonding with an upper surface of the color display that is shaped as a simple curve, and wherein an upper surface of the nail blank is shaped as a compound curve.

7. The digital nail system according to claim 1 wherein an underside of the electrical insulating section is shaped as a simple curve, and further comprises a nail interface adapter having an upper surface shaped as a simple curve for bonding with the underside of the electrical insulating section, and an underside shaped as a compound curve for directly bonding with the user's nail.

8. The digital nail system according to claim 7 wherein edges of the nail interface adapter and edges of the nail blank are bonded together so that a load on the nail interface adapter is transferred to the nail blank and not to the color display.

9. The digital nail system according to claim 1 wherein an outer exposed surface of the nail blank is etched to optically alter passage of light through the nail blank.

10. The digital nail system according to claim 1 wherein a subsurface of the nail blank comprises micro air bubbles to optically alter passage of light through the nail blank.

11. The digital nail system according to claim 1 wherein the plurality of conductive interface pads are spaced apart in a lengthwise direction of the support layer.

12. The digital nail system according to claim 1 wherein the plurality of conductive interface pads are spaced apart in a widthwise direction of the support layer.

13. The digital nail system according to claim 1 wherein the color programming device comprises:

a housing;

a wireless transceiver carried by the housing and configured to communicate with the client device to receive a subset of color options;

a controller carried by the housing and coupled to the wireless transceiver and the nail insertion sensor;

a display carried by the housing and coupled to the controller and configured to display the subset of color options;

a user input carried by the housing and coupled to the controller and configured to select at least one color option from the subset of color options in response to input by the user; and

drive circuitry carried by the housing and coupled to the controller and the plurality of contact pins, and configured to generate the programming signals for programming the color display to the at least one user-selected color option in response to the nail insertion sensor sensing insertion of the artificial nail assembly into the opening in the color programming device.

14. The digital nail system according to claim 13 wherein the color programming device further comprises a temperature sensor carried by the housing and coupled to the controller and configured to provide a temperature value to the controller, and wherein the programming signals are generated based on the temperature value and the at least one user-selected color option.

15. The digital nail system according to claim 1 wherein the color programming device is configured as a dongle to be coupled to the client device, with the dongle comprising:

a housing;

a controller carried by the housing and coupled to the nail insertion sensor, and configured to receive from the client device the at least one user-selected color option; and

drive circuitry carried by the housing and coupled to the controller and to the plurality of contact pins, and configured to generate the programming signals for programming the color display to the at least one user-selected color option in response to the nail insertion sensor sensing insertion of the artificial nail assembly into the opening in the color programming device.

16. The digital nail system according to claim 15 wherein the dongle further comprises a temperature sensor carried by the housing and coupled to the controller, and configured to provide a temperature value to the client device, and wherein the programming signals are generated based on the temperature value and the at least one user-selected color option.

17. A color programming device for an artificial nail assembly, comprising:

a housing;

an input carried by the housing and configured to receive from a client device at least one user-selected color option for a color display in the artificial nail assembly;

a controller carried by the housing and coupled to the input;

a plurality of contact pins within an opening in a side of the housing, and configured to contact the artificial nail

assembly when the artificial nail assembly is inserted into the opening;

a nail insertion sensor carried by the housing and coupled to the controller, and configured to sense insertion of the artificial nail assembly into the opening in the side of the housing; and

drive circuitry carried by the housing and coupled to the controller and to the plurality of contact pins, and configured to generate programming signals for programming the color display to the at least one user-selected color option in response to the nail insertion sensor sensing insertion of the artificial nail assembly into the opening in the side of the housing.

18. The color programming device according to claim 17 wherein the nail insertion sensor comprises:

a nail position pivot arm aligned with the opening in the side of the housing, and pivotable between a first position and a second position, with the first position corresponding to the opening being void of the artificial nail assembly and with the second position corresponding to insertion of the artificial nail assembly into the opening; and

a nail position switch coupled to the controller and in an inactive position when the nail position pivot arm is in the first position, and in an active position when the nail position pivot arm is in the second position causing the drive circuitry to generate the programming signals.

19. The color programming device according to claim 18 wherein the nail position pivot arm comprises a lower pivot arm section in contact with the nail position switch, and an upper

pivot arm section contacting an underside of the housing, with the upper pivot arm section functioning as a spring.

20. The color programming device according to claim 18 wherein the nail position pivot arm is biased to the first position.

21. The color programming device according to claim 17 wherein the opening in the side of the housing has a curved shape to guide the artificial nail assembly toward a center of the opening, with the curved shape matching an underside of the artificial nail assembly.

22. The color programming device according to claim 18 comprising:

a pair of horizontal alignment guides to align the artificial nail assembly in a horizontal direction upon insertion within the opening; and

wherein an underside of the nail position pivot arm that makes contact with the artificial nail assembly is shaped to provide vertical alignment of the artificial nail assembly upon insertion within the opening.

23. The color programming device according to claim 22 wherein the nail position pivot arm and the pair of horizontal alignment guides are configured as a monolithic unit.

24. The color programming device according to claim 17 wherein the input comprises a wireless transceiver configured to communicate with the client device to receive the at least one user-selected color option.

25. The color programming device according to claim 17 wherein the input comprises a connector for coupling to the client device to receive the at least one user-selected color option.

26. The color programming device according to claim 17 further comprising:

a display carried by the housing and coupled to the controller, and configured to display color options for the color display in the artificial nail assembly; and

an input device carried by the housing and coupled to the controller, and configured to select one of the color options as the at least one user-selected color option based on user input.

27. The color programming device according to claim 17 further comprising a temperature sensor carried by the housing and coupled to the controller, and configured to provide a temperature value to the controller, and wherein the drive circuitry generates the programming signals based on the temperature value and the at least one user-selected color option.

28. The color programming device according to claim 17 wherein the color programming device is configured as a dongle.

29. A method for operating a color programming device to program a color display in an artificial nail assembly, the method comprising:

receiving from a client device at least one user-selected color option;

inserting the artificial nail assembly into an opening in a side of the color programming device, with the artificial nail

assembly contacting a plurality of contact pins in the color programming device;

operating a nail insertion sensor to sense when the artificial nail assembly is inserted into the opening in the side of the color programming device; and

generating programming signals to program the color display to the at least one user-selected color option in response to the nail insertion sensor sensing insertion of the artificial nail assembly.

30. The method according to claim 28 wherein the at least one user-selected color option is received wirelessly from the client device.

31. The method according to claim 28 wherein the at least one user-selected color option is received after inserting the color programming device into the client device.

32. The method according to claim 28 further comprising:

displaying color options for the color display in the artificial nail assembly; and

selecting one of the color options as the at least one user-selected color option based on user input.

33. The method according to claim 28 further comprising determining a temperature of the color programming device, and wherein the programming signals are generated based on the temperature and the at least one user-selected color option.

34. The method according to claim 28 wherein the color programming device is configured as a dongle.