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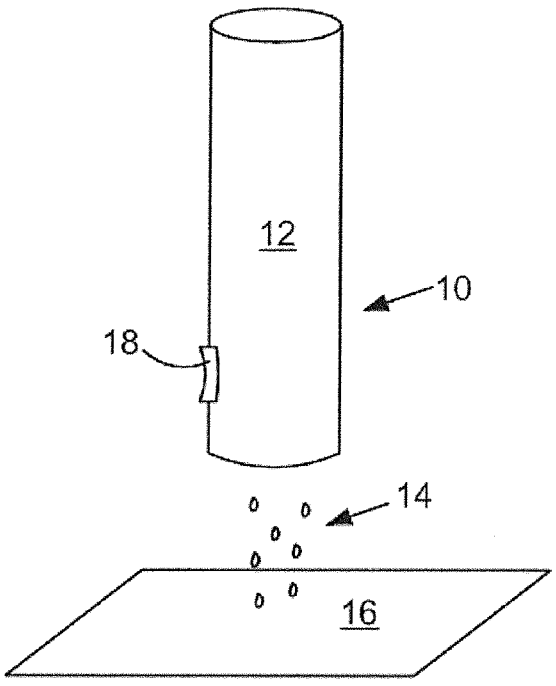
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[Continued on next page]

(54) Title: INK SET AND METHOD FOR INK JET PRINTING



(57) Abstract: A cosmetic ink set, method for printing and printer containing the ink set. The ink set includes at least two of a) a cyan ink that includes a cosmetically approved cyan dye; b) a magenta ink that includes a cosmetically approved magenta dye; and c) a yellow ink that includes a cosmetically approved yellow dye. Each of the cyan ink, magenta ink and yellow ink contains 1) a cosmetically approved humectant; 2) a cosmetically approved surfactant; and 3) water in an amount sufficient to provide 100 wt.% for each of the cyan, magenta and yellow inks based on a total weight of the ink.

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Description

Title of Invention: INK SET AND METHOD FOR INK JET PRINTING

Technical Field

[0001] The disclosure is directed to an ink set for printing full color images intended for cosmetic applications and in particular an ink set for full color printing that includes cosmetically approved cyan, magenta, and yellow dyes and ink composition components.

Background Art

[0002] Current colorants and ink formulation materials are not on a list of approved chemicals for use in cosmetic applications; thus making current inks unacceptable for use as cosmetic inks. Traditional ink jet inks include a carrier fluid, a humectant that may include water-soluble or organic solvents, a dye or pigment, surface active agents, and other ingredients. Traditional inks have been optimized for application to various substrates, including porous and non-porous surfaces, while maintaining a color spectrum defined by the L*a*b* values of the individual inks.

[0003] The L*a*B* values are defined by the Commission Internationale de l'Eclairage (CIE) and were modeled after a color-opponent theory stating that two colors cannot be red and green at the same time or yellow and blue at the same time. L* indicates lightness, a* is the red/green coordinate, and b* is the yellow/blue coordinate. Deltas for L* (ΔL*), a* (Δa*) and b* (Δb*) may be positive (+) or negative (-). The total difference, Delta E (ΔE*), however, is always positive. Accordingly, ΔL* (L* sample minus L* standard) = difference in lightness and darkness (+ = lighter, - = darker); Δa* (a* sample minus a* standard) = difference in red and green (+ = redder, - = greener); Δb* (b* sample minus b* standard) = difference in yellow and blue (+ = yellower, - = bluer); and ΔE* = total color difference. In order to determine the total color difference between all three coordinates, the following formula is used:

$$\Delta E^* = [\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}]1/2.$$

Summary of Invention

Technical Problem

[0004] Slight changes in ink formulations may provide dramatic changes in the L*a*b* values of the primary colors, cyan, magenta, and yellow as well as other properties of the inks. For example, formulation changes may affect the jetting properties of the inks including the viscosity, droplet size, droplet velocity, drying time, color fastness, and banding and/or graininess of images printed with the inks. While ink jet inks have been formulated for use in business and home printing applications to meet the foregoing re-

quirements, such inks cannot be used for printing on human nails or skin. Many of the ingredients used in conventional inks are not approved for such applications.

[0005] Furthermore, not all cosmetically approved compositions that can be used in inks will provide suitable thermal ink jet ink compositions that are equivalent in performance to conventional ink jet inks. Accordingly, there is a need to provide ink jet ink formulations and ink sets that meet cosmetic standards while maintaining traditional print quality and printing reliability standards.

Solution to Problem

[0006] In view of the foregoing, an embodiment of the disclosure provides a cosmetic ink set for thermal ink jet printing. The cosmetic ink set includes at least two of a) a cyan ink that includes a cosmetically approved cyan dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the cyan ink; b) a magenta ink that includes a cosmetically approved magenta dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the magenta ink; and c) a yellow ink that includes a cosmetically approved yellow dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the yellow ink . Each of the cyan ink, magenta ink and yellow ink contains: a cosmetically approved humectant in an amount ranging from about 7 to about 30 wt.% based on a total weight of the ink; a cosmetically approved surfactant in an amount ranging from about 0.05 to about 5.0 wt. % based on a total weight of the ink; and water in an amount sufficient to provide 100 wt.% for each of the cyan, magenta and yellow inks based on a total weight of the ink.

[0007] Another embodiment provides a method of printing with cosmetic inks on human nails and skin. The method includes providing an ink jet pen and an ink set for full color thermal ink jet printing, the ink set includes a) a cyan ink that includes a cosmetically approved cyan dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the cyan ink; b) a magenta ink that includes a cosmetically approved magenta dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the magenta ink; and c) a yellow ink that includes a cosmetically approved yellow dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the yellow ink. Each of the cyan ink, magenta ink and yellow ink contains a cosmetically approved humectant in an amount ranging from about 7 to about 30 wt.% based on a total weight of the ink; a cosmetically approved surfactant in an amount ranging from about 0.08 to about 5.0 wt. % based on a total weight of the ink; and water in an amount based on a total weight of the ink sufficient to provide 100 wt.% for each of the cyan, magenta and yellow inks based on a total weight of the ink. The ink set is ejected in a predetermined amount onto the skin, finger nails or toe nails of a person.

[0008] A further embodiment of the disclosure provides an ink jet pen that includes a cyan, magenta and yellow ink set for full color printing on humans. The ink jet pen contains a) a cyan ink comprising a cosmetically approved cyan dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the cyan ink; b) a magenta ink comprising a cosmetically approved magenta dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the magenta ink; and c) a yellow ink comprising a cosmetically approved yellow dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the ink. Each of the cyan ink, magenta ink and yellow ink contains: a cosmetically approved humectant in an amount ranging from about 7 to about 30 wt.% based on a total weight of the ink; a cosmetically approved surfactant in an amount ranging from about 0.05 to about 5.0 wt. % based on a total weight of the ink; and water in an amount sufficient to provide 100 wt.% for each of the cyan, magenta and yellow inks based on a total weight of the ink.

[0009] An advantage of the foregoing embodiments is that the disclosure provides ink sets that may be used to provide a full spectrum of colors for use in cosmetic applications. The ink sets may be used in a micro-fluid ejection head thereby providing more precise control of the ink color that is printed and more precise placement of ink on skin, finger nail, toe nails, etc. The ink set may also be suitable for improved color matching while maintaining low banding and graininess printing scores. Other features and advantages of the disclosed embodiments may be evident by reference to the following disclosure.

Advantageous Effects of Invention

[0010] The cosmetic ink set according to the present invention can provide ink jet ink formulations and ink sets that meet cosmetic standards while maintaining traditional print quality and printing reliability standards.

Brief Description of Drawings

[0011] [fig.1]FIG. 1 is a perspective view, not to scale, of a hand held cosmetic ink jet printing device.

[fig.2]FIG. 2 is a perspective view, not to scale, of a maintenance station for the cosmetic ink jet printing device of FIG. 1.

Description of Embodiments

Embodiment 1

[0012] Embodiments of the disclosure provide, for the first time, a full color ink set and hand held ink jet printer that includes only cosmetically approved ink ingredients. The formulation is specifically adapted for use with a thermal ink jet printer and can substantially match traditional print quality and thermal ink jet printing reliability. The quality and reliability of the cosmetically suitable ink formulations may be determined

using various comparisons to traditional ink jet inks, such as graininess, banding, and color gamut.

[0013] Accordingly, it was necessary to identify certain cosmetic grade colorants to determine if any such colorants could be used to match traditional ink jet ink colorants. Only the basic cyan, magenta and yellow colorants were sought as all other colors could be produced from a combination of these colorants. The colorants had to not only be comparable to the traditional ink jet ink colorants, they also had to be compatible with other ink components including humectants, surfactants, solvents, and the like.

[0014] Suitable colorants may be selected from cosmetic grade dyes or pigments, with cosmetic or food grade dyes being particularly suitable for making a full color ink set according to the disclosure. Of the available cosmetic grade colorants, the following colorants were identified as useful for making ink jet formulations according to the disclosure.

[0015] The blue dyes may be selected from benzenemethanaminium, N-ethyl-N-[4-[[4-[ethyl[(3-sulfophenyl)methyl]amino]phenyl](4-hydroxy-2-sulfophenyl) methylene]-2,5-cyclo-hexadien-1-ylidene]-3-sulfo-,inner salt, disodium salt (FOOD BLUE 2); sodium 1-amino-9,10-dioxo-4-phenylaminoanthracene-2-sulphonate (ACID BLUE 5); benzenemethanaminium, N-ethyl-N-[4-[[4-[ethyl[(3-sulfophenyl)methyl]amino]phenyl](2-sulfophenyl)methylene]-2,5-cy-clohexadien-1-ylidene]- 3-sulfo-, inner salt, diammonium salt (ACID BLUE 9); and benzen-emethanaminium,N-[4-[[4-[(4-ethoxyphenyl)amino]phenyl][4-[ethyl[(3-sulfophenyl)-methyl]amino]-2-methylphenyl]methylene]-3-methyl-2,5-cyclohexadien-1-ylidene]-N-ethyl-3-sulfo-, inner salt, monosodium salt (BRILLIANT BLUE).

[0016] The red dyes may be selected from 1-(2,4-xylylazo)-2-naphthol-3,6-disulphonic acid disodium salt (ACID RED 26); trisodium 3-hydroxy-4-(4-sulfonato-1-naphthylazo)-2,7-naphthalenedisulfonate (ACID RED 27); 7-naphthalenedisulfonicacid,4-amino-5-hydroxy-6-phenylazo-disodium salt (ACID RED 33); sulforhodamine B monosodium salt (ACID RED 52); 2-(2,4,5,7-tetrabromo-6-hydroxy-3-oxo-3h-xanthen-9-yl)-benzoic acid disodium (ACID RED 87); 2',4',5',7'-tetrabromo-4,5,6,7-tetrachloro-fluoresceidisodium salt (ACID RED 92); 4,5,6,7-tetrachloro-2',4',5',7'-tetraiodo-fluoresceidisodium salt (ACID RED 94); and xanthylium,9-(2-carboxyphenyl)-3-[(2-methylphenyl)amino]-6-[(2-methyl-4-sulfophen yl)amino]-hydroxide, inner salt, monosodium salt (ACID VIOLET 9).

[0017] The yellow dyes may be selected from 2,4-dinitro-1-naphthol-7-sulfo disodium salt (ACID YELLOW 1); benzenesulfonic acid,

4-4,5-dihydro-3-methyl-5-oxo-4-(phenylazo)-1H-pyrazol-1-yl-,sodium salt (ACID YELLOW 11); 1H-Pyrazole-3-carboxylic acid, 4,5-dihydro-5-oxo-1-(4-sulfophenyl)-4-[(4-sulfophenyl)azo]-,trisodium salt (ACID YELLOW 23); Sodium 5-chloro-2-(5-hydroxy-3-methyl-4-(4-((4-methylphenyl)sulphonyloxy)phenylazo)-pyrazol-1-yl)benzenesulphonate (ACID YELLOW 40); and 9-(o-carboxyphenyl)-6-hydroxy-3h-xanthen-3-one,disodiumsalt (ACID YELLOW 73).

[0018] Each of the foregoing dyes must not only be compatible with other ingredients in the inks, but must also be compatible with one another and provide color match reproduction, jetting ability, and jetting reliability that is equal to or better than traditional ink jet ink sets. Accordingly, was necessary to consider the solubility of the dye in the ink formulation, the viscosity of the resulting ink formulation, the drying time of the ink formulation on skin or nails, and the surface tension of the ink formulation on skin or nails.

[0019] Water soluble dyes are dyes that are substantially soluble in aqueous solutions. Such dyes include acid dyes which are dyes that contain acidic groups, such as sulphonic acid groups. The amount of cyan, magenta and yellow dyes in each ink formulation may range from about 1 to about 6 wt.% base on a total weight of each of the ink formulations. A typical amount of dye in each ink formulation may range from about 2 to about 4 percent by weight based on a total weight of the ink formulation.

[0020] Another component of the ink formulations described herein is one or more humectants. The humectants, like the dyes described above, are cosmetically approved humectants. Humectants are hydrophilic compounds that are used to keep the formulations from drying out too quickly on the ejection heads. Suitable cosmetically improved humectants include, but are not limited to, polyhydroxy compounds such as 1,2- propanediol, 1,3-propandiol, dipropylene glycol, glycerol, polyethylene glycol, polypropylene glycol, polybutylene glycol, and mixtures thereof. The amount of humectant in each ink formulation may range from about 7 to about 30 % by weight based on a total weight of the ink formulation. A typical ink formulation may contain from about 15 to about 25 wt.% humectant based on a total weight of the ink formulation.

[0021] A minor amount of penetrant may be used in each of the ink formulations described above. The penetrant is added to the ink compositions to improve penetration by the ink drops into the surface of a substrate and to reduce or eliminate intercolor bleeding (i.e., lateral bleeding of color). Penetrants for use in the compositions described herein may include 1,2 alkyl diols containing from 4 to 10 carbon atoms in the alkyl group. Suitable cosmetically approved penetrants may be selected from 1,2-hexandiol, 1,2-pentanediol, and mixtures thereof. The penetrant is present in the ink composition in an amount of from between about 0.05 to about 5% by weight based on a total

weight of the ink composition. A desirable amount of penetrant in each of the ink formulations may range from about 1 to about 4 percent by weight based on a total weight of the ink formulation.

[0022] Another component of the ink formulations described herein is a cosmetically approved nonionic surfactant. The surfactant is included in the ink formulation in order to reduce the evaporation rate of components of the ink formulation in order to increase the decap time for the ink jet print head and to aid in cleaning the ink jet print head between printing cycles. Such surfactants include, but are not limited to polyoxyethylene sorbitan monolaurate, polyoxyethylene sorbitan monostearate, polyoxyethylene sorbitan monooleate, N-(coconut oil acyl)-N-methyltaurine sodium salt, and 1,4-bis(2-ethylhexyl)-sodium sulfosuccinate. The amount of surfactant in each of the ink formulations described above may range from about 1 to about 3 wt.% base on a total weight of the ink formulation.

[0023] Each of the components described above are water soluble components of the ink formulations. Accordingly, a major component of each of the ink formulations described above is water. Deionized water is preferred and the amount of water may range from about 50 to about 90 percent by weight based on a total weight of the ink formulation. A typical amount of water in each of the ink formulations may range from about 60 to about 80 percent by weight based on a total weight of the ink formulation.

[0024] Exemplary non-limiting ink formulations are provided in the following table.

[0025] [Table 1]

		Wt. %		Wt. %		Wt. %
Colorant	Blue Dye	3.0	Red Dye 1	1.7	Yellow Dye	3.5
			Red Dye 2	0.8		
Humectants	1,2-propanediol	7.0	1,2-propanediol	7.0	1,2-propanediol	7.0
	1,3-propanediol	7.0	1,3-propanediol	7.0	1,3-propanediol	7.0
	Dipropylene glycol	6.0	Dipropylene glycol	6.0	Dipropylene glycol	6.0
Penetrant	1,2-hexanediol	2.5	1,2-hexanediol	2.5	1,2-hexanediol	2.5
Surfactant	polyoxyethylene sorbitan monooleate	1.5	polyoxyethylene sorbitan monooleate	1.5	polyoxyethylene sorbitan monooleate	1.5
Water		73.0		73.5		72.5

[0026] The amount of a typical fluid droplet for an ink formulation according to the disclosure may range from about 2000 to about 4000 picograms. Corresponding fluid droplet diameters may range from about 10 μm to about 20 μm.

[0027] Ink sets generally in accordance with the above formulations were tested in conventional ink jet printers to determine the drop mass, droplet velocity, and printing stability over a range of printing frequencies. All of the tests were conducted at 45 ° C ink jet head temperature and 11 volts. The firing sequence for the cosmetic ink set was

as follows: pre-fire pulse width 200 nsec; delay pulse width 800 nsec; main fire pulse width 470 nsec. The firing sequence for the conventional ink set was as follows: pre-fire pulse width 200 nsec; delay pulse width 800 nsec; main fire pulse width 450 nsec. The cosmetic ink sets described herein TABLE 2 were compared to conventional ink jet ink sets TABLE 3 as shown in the following tables.

[0028] [Table 2]

	9 kHz Frequency		18 kHz Frequency	
Cosmetic Ink Set	Drop Mass (ng)	Velocity (m/sec)	Drop Mass (ng)	Velocity (m/sec)
Cyan Ink 1	2.96	8.8	3.49	9.6
Cyan Ink 2	3.60	8.1	3.07	8.9
Magenta Ink 1	2.91	8.6	3.53	9.4
Magenta Ink 2	3.66	8.1	2.93	8.7
Yellow Ink 1	2.93	8.8	3.66	9.6
Yellow Ink 2	3.66	8.1	2.89	8.9

[0029] [Table 3]

	9 kHz Frequency		18 kHz Frequency	
Conventional Ink Set	Drop Mass (ng)	Velocity (m/sec)	Drop Mass (ng)	Velocity (m/sec)
Cyan Ink 1	3.68	9.0	3.323	9.7
Cyan Ink 2	3.36	9.3	3.83	10.1
Magenta Ink 1	3.64	8.8	3.19	9.7
Magenta Ink 2	2.85	9.2	3.76	9.9
Yellow Ink 1	3.61	8.9	3.08	9.7
Yellow Ink 2	2.77	9.3	3.73	10.0

[0030] As shown by the foregoing tables, the cosmetic ink set had a drop mass ranging from 2.91 to 3.66 ng at 9 kHz and from 2.89 to 3.66 ng at 18 kHz. This compared favorably with the drop mass of the conventional ink set that ranged from 2.77 to 3.68 ng at 9 kHz and from 3.08 to 3.83 ng at 18 kHz. The droplet velocity of the cosmetic ink set ranged from 8.1 to 8.8 m/sec at 9 kHz and from 8.7 to 9.6 m/sec at 18 kHz while the conventional ink set had droplet velocities of 8.8 to 9.3 m/sec at 9 kHz and from 9.7 to 10.1 m/sec at 18 kHz. Accordingly, the cosmetic ink set performed similarly to the conventional ink set with regard to droplet velocity.

[0031] An important feature of the cosmetic ink set according to the disclosure is the reliability of the ink set in an ink jet printer. A measure of the reliability of the ink set is

its graininess score and its banding score after multiple (such as 8 passes) of the ink jet print head over a wiper after printing. The banding score looks for missing ink droplets which shows up as bands or lines across a printed page. A banding score of less than 0.15, such as from 0 to about 0.11 is suitable for most printing application. The cosmetic ink set described herein had a banding score of from 0.04 to 0.08.

[0032] The graininess score is used to determine misdirection clustering such that individual ink droplets can be detected on a substrate. An acceptable graniness score ranging from 0.1 to less than 1.2 for is acceptable. A graininess score above 1.3 is typically not acceptable for most printing applications. The cosmetic ink set according to the disclosure had a graniness score ranging from about 0.2 to about 1.03.

[0033] The foregoing ink set compositions may be useful in a variety of applications directed to decoration and/or enhancement of mammalian skin and/or nails. The methods of use for the compositions disclosed herein include, but are not limited to: 1) methods of applying a color cosmetic to skin; 2) methods of providing even skin tone; 3) methods of masking the appearance of vellus hair on skin; 4) methods of concealing blemishes and/or imperfections in human skin, including acne, age spots, freckles, moles, scars, under eye circles, birth marks, post-inflammatory hyperpigmentation; 5) methods of enhancing or modifying skin color such as lightening, darkening, making more pink, making more yellow, making less dull, making less ashy, making less orange, making more radiant; 6) methods of concealing vitiligo; 7) methods of decorating the skin and/or nails; and the like. When the cosmetic ink set is being applied to substantially non-porous surfaces, an ink receptive layer may be applied to the surface prior to printing. Ink receptive layers may include mixtures of pigments and fibers in admixture with a binder to provide a suitable ink receptive surface.

[0034] The cosmetic ink set described herein may be used in a hand-held micro-fluid printing device such as an ink jet pen 10 shown in FIG. 1. The pen 10 includes a body 12 that houses an ink cartridge, a rechargeable battery, ink jet print head, and a controller. The ink cartridge contains the cosmetic ink set described herein for full color printing. Ejection of ink droplets 14 from the pen 10 onto a substrate 16 such as skin or nails is controlled by an activation switch 18 on the body 12 of the pen 10. A charging and ink jet head cleaning station 20 may be provided to recharge the pen 10 and clean the ink jet print head when the pen 10 is not in use. Other ink jet printing devices, including, but not limited to, conventional ink jet printers may also be used with the cosmetic ink set described herein.

[0035] It is contemplated, and will be apparent to those skilled in the art from the preceding description and the accompanying drawings, that modifications and changes may be made in the embodiments of the disclosure. Accordingly, it is expressly intended that the foregoing description and the accompanying drawings are illustrative of exemplary

embodiments only, not limiting thereto, and that the true spirit and scope of the present disclosure be determined by reference to the appended claims.

Reference Signs List

[0036] 10: ink jet pen
12: body
14: ink droplet
16: substrate
18: activation switch
20: cleaning station

Claims

[Claim 1] A cosmetic ink set for thermal ink jet printing comprising at least two of:

a) a cyan ink comprising a cosmetically approved cyan dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the cyan ink;

b) a magenta ink comprising a cosmetically approved magenta dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the magenta ink; and

c) a yellow ink comprising a cosmetically approved yellow dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the yellow ink;

wherein each of the cyan ink, magenta ink, and yellow ink contains:

1) a cosmetically approved humectant in an amount ranging from about 7 to about 30 wt.% base on a total weight of the ink;

2) a cosmetically approved surfactant in an amount ranging from about 0.05 to about 5.0 wt. % based on a total weight of the ink; and

3) water in an amount sufficient to provide 100 wt.% for each of the cyan, magenta and yellow inks based on a total weight of the ink.

[Claim 2] The cosmetic ink set of claim 1, wherein the humectants are selected from the group consisting of 1,2- propanediol, 1,3-propandiol, dipropylene glycol, glycerol, polyethylene glycol, polypropylene glycol, polybutylene glycol and mixtures of two or more of the foregoing.

[Claim 3] The cosmetic ink set of claim 1 or 2, wherein the surfactant is selected from the group consisting of polyoxyethylene sorbitan monolaurate, polyoxyethylene sorbitan monostearate, polyoxyethylene sorbitan monooleate, N-(coconut oil acyl)-N-methyltaurine sodium salt, 1,4-bis(2-ethylhexyl)-sodium sulfosuccinate, and mixtures thereof.

[Claim 4] The cosmetic ink set of any one of claims 1 to 3, wherein the amount of water in each of cyan, magenta and yellow inks ranges from about 50 to about 90 wt.% based on a total weight of the ink.

[Claim 5] The cosmetic ink set of any one of claims 1 to 4, wherein the cosmetically approved cyan dye is selected from the group consisting of FOOD BLUE 2; ACID BLUE 5, ACID BLUE 9, and BRILLIANT BLUE.

[Claim 6] The cosmetic ink set of any one of claims 1 to 5, wherein the cos-

metically approved magenta dye is selected from the group consisting of ACID RED 26, ACID RED 27, ACID RED 33, ACID RED 52, ACID RED 87, ACID RED 92 ACID RED 94, and ACID VIOLET 9.

[Claim 7] The cosmetic ink set of any one of claims 1 to 6, wherein the cosmetically approved yellow dye is selected from the group consisting of ACID YELLOW 1, ACID YELLOW 11, ACID YELLOW 23, ACID YELLOW 40, and ACID YELLOW 73.

[Claim 8] A cosmetic ink comprising a mixture of two or more of the cyan ink, magenta ink and yellow inks of any one of claims 1 to 7.

[Claim 9] The cosmetic ink of claim 8, further comprising a penetrant, wherein the penetrant is selected from the group consisting of 1,2 alkyl diols containing from 4 to 10 carbon atoms in the alkyl group.

[Claim 10] A method of printing with cosmetic inks on human nails and skin comprising providing an ink jet pen and an ink set for full color thermal ink jet printing, the ink set comprising:

a) a cyan ink comprising a cosmetically approved cyan dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the cyan ink;

b) a magenta ink comprising a cosmetically approved magenta dye in an amount ranging from about 1 to about 6 wt.% based on the total weight of the magenta ink; and

c) a yellow ink comprising a cosmetically approved yellow dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the yellow ink;

wherein each of the cyan ink, magenta ink, and yellow ink contains:

1) a cosmetically approved humectant in an amount ranging from about 7 to about 30 wt.% based on a total weight of the ink;

2) a cosmetically approved surfactant in an amount ranging from about 0.08 to about 5.0 wt. % based on a total weight of the ink; and

3) water in an amount sufficient to provide 100 wt.% for each of the cyan, magenta and yellow inks based on a total weight of the ink; and

the method comprising:

ejecting the ink set in a predetermined amount onto the skin, finger nails or toe nails of a person.

[Claim 11] The method of claim 10, further comprising pre-coating nails with an ink receptive layer prior to printing on the finger nails or toe nails.

[Claim 12] An ink jet pen comprising a cyan, magenta, and yellow ink set for full color printing on humans, comprising:

a) a cyan ink comprising a cosmetically approved cyan dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the cyan ink;
b) a magenta ink comprising a cosmetically approved magenta dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the magenta ink; and
c) a yellow ink comprising a cosmetically approved yellow dye in an amount ranging from about 1 to about 6 wt.% based on a total weight of the yellow ink;
wherein each of the cyan ink, magenta ink, and yellow ink contains:
1) a cosmetically approved humectant in an amount ranging from about 7 to about 30 wt.% based on a total weight of the ink;
2) a cosmetically approved surfactant in an amount ranging from about 0.05 to about 5.0 wt. % based on a total weight of the ink; and
3) water in an amount sufficient to provide 100 wt.% for each of the cyan, magenta and yellow inks based on a total weight of the ink.

[Claim 13] The ink jet pen of claim 12, wherein a printed image from the ink jet pen has a banding score of less than about 0.09.

[Claim 14] The ink jet pen of claim 12, wherein a printed image from the ink jet pen has a graininess score of less than about 1.2.

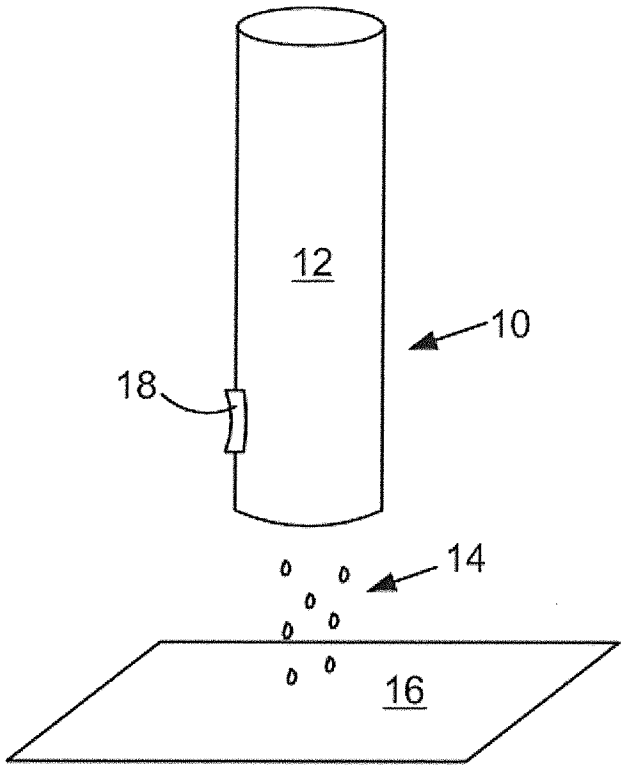
[Claim 15] The ink jet pen of any one of claims 12 to 14, wherein the humectant comprises a mixture of two or more cosmetically approved humectants.

[Claim 16] The ink jet pen of any one of claims 12 to 15, wherein each of the cyan, magenta and yellow inks further comprises a cosmetically approved penetrant.

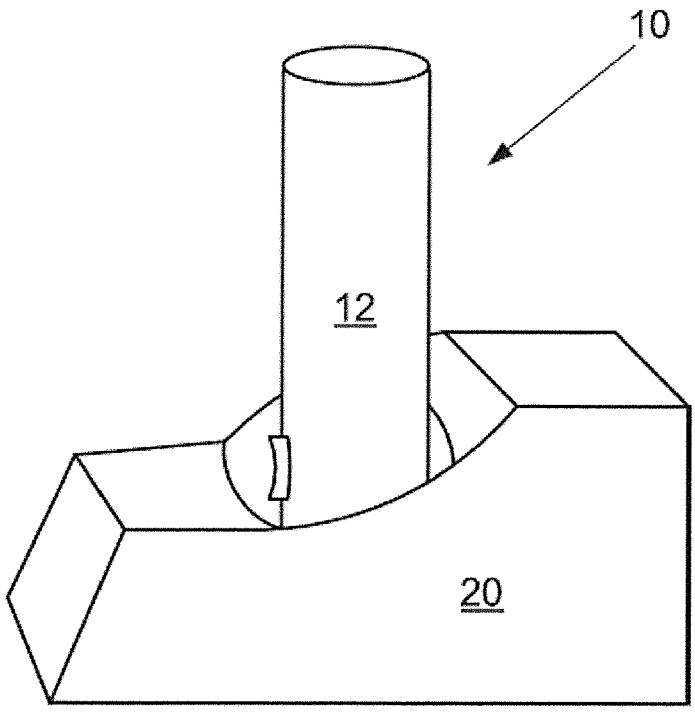
[Claim 17] The ink jet pen of any one of claims 12 to 15, wherein the magenta ink comprises a mixture of cosmetically approved dyes.

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[Fig. 1]



[Fig. 2]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/084051

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. A61K8/34, A45D29/18, A45D34/04, A61K8/39, A61K8/42, A61K8/46, A61K8/49, A61Q1/08, A61Q3/02, B41J2/01, B41J2/21, C09D11/40

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2017
Registered utility model specifications of Japan 1996-2017
Published registered utility model applications of Japan 1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2006/0229382 A1 (Karl-Heinz Schwelkart, et al.) 2006.10.12, Claims, Example 1-16, Comparative Example 1-3, [0042] [0054]-[0060] [0071]-[0073] [0089] & JP 2006-524279 A & WO 2004/094541 A1 & EP 1618159 A1 & KR 10-2006-0008911 A & CN 1771307 A	1-9 3-17
X Y	US 2004/0206271 A1 (Rudolf Randler, et al.) 2004.10.21, Claims, Example 1-12, [0027]-[0049] [0065] [0106] & JP 2004-535506 A & WO 2003/008503 A1 & EP 1409592 A1 & CN 1610728 A & KR 10-2004-0018447 A	1-2,4-9 3-17

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

* Special categories of cited documents:
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"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
17.01.2017	31.01.2017

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/084051

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2003/0076372 A1 (Stuart D. Asakawa) 2003.04.24, [0021] [0025] & JP 2003-165937 A & EP 1304363 A2	10-17
Y	US 2004/0078278 A1 (Christophe Dauga, et al.) 2004.04.22, Claims,[0041] [0055]-[0056] & JP 2004-501707 A & WO 2002/001499 A2 & EP 1295253 A2	11

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CLASSIFICATION OF SUBJECT MATTER
A61K8/34(2006.01)i, A45D29/18(2006.01)i, A45D34/04(2006.01)i,
A61K8/39(2006.01)i, A61K8/42(2006.01)i, A61K8/46(2006.01)i,
A61K8/49(2006.01)i, A61Q1/08(2006.01)i, A61Q3/02(2006.01)i,
B41J2/01(2006.01)i, B41J2/21(2006.01)i, C09D11/40(2014.01)i