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(54) **INKJET PRINTING METHOD**

(57) This disclosure is directed to producing an improved coloring effect, while suppressing smearing of a colorant in the inkjet textile printing. A fabric is printed by inkjet printing with a first liquid containing a dyeing as-

sistant. Then, the fabric is further printed by inkjet printing with a second liquid containing a colorant and a water-soluble photo-curable resin. The second liquid applied on the fabric is then irradiated with light.

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Description

TECHNICAL FIELD

[0001] This disclosure relates to an inkjet printing method, more particularly to an inkjet printing method for printing, for example, images or characters on fabrics.

BACKGROUND ART

[0002] Inkjet inks have been known to be relatively low in viscosity. A fabric printed by inkjet printing, therefore, may be quickly impregnated and smeared with such an ink.

[0003] A fabric recording method has so far been disclosed as a smearing-controllable technique. To record an image on a fabric, this method uses an inkjet ink for textile printing at least containing a colorant, and a water-soluble polymerizable compound by way of irradiation of an external energy ray. After the fabric is printed with the inkjet ink, the water-soluble polymerizable compound is irradiated with the external energy ray to generate a polymerized compound. The fabric, after being subjected to coloring treatment, is rinsed with water (Patent Literature 1).

CITATION LIST

PATENT LITERATURE

[0004] Patent Literature 1: JP 2006-144180 A (disclosed on June 8, 2006)

SUMMARY

TECHNICAL PROBLEM

[0005] Patent Literature 1 describes briefly thickening the inkjet ink containing a colorant such as dye and a dyeing assistant promoting dyeing on the fabric by tentatively adding such a compound. This may certainly prevent smearing of the ink, while possibly deterring the assistant from penetrating into the fabric. As a result, an expected coloring effect can be limited on the fabric surface alone.

[0006] To address this issue, this disclosure is directed to providing technical solutions for inkjet textile printing that may produce an improved coloring effect while suppressing the occurrence of ink smearing.

SOLUTIONS TO PROBLEM

[0007] The inventors have been encountered by this technical challenge and found out as a result of their keen studies and researches that, when a fabric is printed by inkjet printing, using a dyeing assistant separately from a colorant, and a water-soluble photo-curable resin could help the dyeing assistant to be more absorbed into the

fabric, consequently achieving two desired purposes; an improved coloring effect, and well-suppressed smearing of the colorant. Then, the inventors finally accomplished their mission.

[0008] An inkjet printing method disclosed herein includes: a first printing step of printing a fabric by inkjet printing with a first liquid containing a dyeing assistant; a second printing step of printing the fabric by inkjet printing subsequent to the first printing step with a second liquid containing a colorant and a water-soluble photo-curable resin; and a light irradiating step of irradiating the second liquid applied on the fabric in the second printing step with light.

[0009] The colorant is preferably difficult to smear to obtain a clear and sharp image, while the dyeing assistant is preferably smeared and well-absorbed into the fabric. According to the configuration, the colorant in the second liquid applied on the fabric may be unlikely to smear by mixing the water-soluble photo-curable resin with the second liquid in addition to the colorant (the second printing step) and by irradiating the second liquid with light (the light irradiating step). In case the dyeing assistant and the colorant are applied on the fabric at once, it may be difficult for the fabric to absorb the dyeing assistant. The configuration, however, applies the dyeing assistant on the fabric separately from and prior to the step of applying the colorant on the fabric. Hence, the dyeing assistant may be well-absorbed into the fabric. Performing the inkjet textile printing may advantageously achieve an improved coloring effect, while suppressing an occurrence of smearing.

[0010] In the inkjet printing method disclosed herein, the first liquid applied on the fabric in the first printing step may preferably be lower in viscosity than the second liquid applied on the fabric in the second printing step.

[0011] The configuration may allow the dyeing assistant to be better absorbed into the fabric.

[0012] The inkjet printing method may preferably further include a thickening step of thickening the first liquid applied on the fabric in the first printing step to a higher degree of viscosity, wherein the thickening step is performed subsequent to the first printing step and prior to the second printing step.

[0013] According to the configuration, by thickening the first liquid applied on the fabric in the first printing step before proceeding to the second printing step, the colorant may be more difficult to smear.

[0014] In the inkjet printing method, preferably, the first liquid may further include a water-soluble photo-curable resin, and the thickening step may further include irradiating the first liquid applied on the fabric in the first printing step with light.

[0015] According to the configuration, the thickening step may successfully increase the first liquid in viscosity.

[0016] In the inkjet printing method, the thickening step may include heating the first liquid applied on the fabric in the first printing step.

[0017] According to the configuration, the thickening

step may successfully increase the first liquid in viscosity.

[0018] In the inkjet printing method, a period of time between when the fabric is printed with the first liquid in the first printing step and when the first liquid is thickened in the thickening step may preferably be greater than a period of time between when the fabric is printed with the second liquid in the second printing step and when the second liquid is irradiated with light in the light irradiating step.

[0019] The configuration may allow the dyeing assistant to be better absorbed into the fabric.

[0020] The inkjet printing method may preferably include performing the first printing step, the thickening step, the second printing step, and the light irradiating step by using an inkjet head, the inkjet head including: a first nozzle used to apply the first liquid in the first printing step; a first light irradiator used to irradiate the first liquid with light in the thickening step; a second nozzle used to apply the second liquid in the second printing step; and a second light irradiator used to irradiate the second liquid with light in the light irradiating step, wherein the first nozzle is located at a position more forward in a main scanning direction than the first light irradiator, the second nozzle is located at a position more forward in the main scanning direction than the second light irradiator, the first nozzle and the first light irradiator are located at positions more rearward in a sub scanning direction than the second nozzle and the second light irradiator, and a distance between the first nozzle and the first light irradiator is greater than a distance between the second nozzle and the second light irradiator.

[0021] According to the configuration, the first printing step, the thickening step, the second printing step, and the light irradiating step may be adequately and conveniently performed by using a single inkjet head. Specifically, this inkjet head is structured to be adequate for the order relation among the first printing step, the thickening step, the second printing step and the light irradiating step, and time intervals to be set between the first printing step and the thickening step and between the second printing step and the light irradiating step. The simplified structure may advantageously achieve an improved coloring effect, while suppressing the occurrence of smearing in performing the inkjet textile printing.

[0022] The inkjet printing method may include performing the first printing step, the thickening step, the second printing step, and the light irradiating step by using an inkjet head, the inkjet head including: a first nozzle used to apply the first liquid in the first printing step; a heater used to heat the first liquid in the thickening step; a second nozzle used to apply the second liquid in the second printing step; and a light irradiator used to irradiate the second liquid with light in the light irradiating step, wherein the first nozzle is located at a position more forward in the main scanning direction than the heater, the second nozzle is located at a position more forward in the main scanning direction than the light irradiator, the first nozzle and the heater are located at positions more rearward in the

sub scanning direction than the second nozzle and the light irradiator, and a distance between the first nozzle and the heater is greater than a distance between the second nozzle and the light irradiator.

[0023] According to the configuration, the first printing step, the thickening step, the second printing step, and the light irradiating step may be adequately and conveniently performed by using a single inkjet head. Specifically, this inkjet head is structured to be adequate for the order relation among the first printing step, the thickening step, the second printing step, and the light irradiating step, and time intervals to be set between the first printing step and the thickening step, and between the second printing step and the light irradiating step. The simplified structure may advantageously achieve an improved coloring effect, while suppressing the occurrence of smearing in performing the inkjet textile printing.

ADVANTAGEOUS EFFECTS OF THE INVENTION

[0024] This disclosure may advantageously afford an improved coloring effect, while suppressing the occurrence of smearing in performing the inkjet textile printing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

FIG. 1 illustrates the principal technical concept of an inkjet printing method according to an embodiment.

FIG. 2 schematically illustrates steps in an inkjet printing method according to an embodiment.

FIG. 3 schematically illustrates structural features of an inkjet head according to an embodiment.

DESCRIPTION OF EMBODIMENTS

[0026] An inkjet printing method disclosed herein includes: a first printing step of printing a fabric by inkjet printing with a first liquid containing a dyeing assistant; a second printing step of printing the fabric by inkjet printing subsequent to the first printing step with a second liquid containing a colorant and a water-soluble photocurable resin; and a light irradiating step of irradiating the second liquid applied on the fabric in the second printing step with light.

[0027] In an embodiment, the inkjet printing method disclosed herein may further include: a thickening step of thickening the first liquid applied on the fabric in the first printing step to a higher degree of viscosity, the thickening step being performed subsequent to the first printing step and prior to the second printing step; a color developing step of prompting color development of the colorant applied on the fabric, the color developing step being performed subsequent to the light irradiating step; and a removing step of removing the water-soluble photocurable resin on the fabric, the removing step being

performed subsequent to the color developing step.

[0028] FIG. 1 illustrates the principal technical concept of an inkjet printing method according to an embodiment of the present disclosure. In FIG. 1, a fabric 1, a first printing layer 2, and a second printing layer 3 are illustrated. FIG. 2 schematically illustrates steps in the inkjet printing method according to an embodiment of the present disclosure.

[0029] The inkjet printing method according to an embodiment of the present disclosure starts with placement of a fabric 1 in an inkjet apparatus. Then, in Step S1, the fabric 1 is printed by inkjet printing with a first liquid containing a dyeing assistant (a first printing step), and the first liquid on the fabric 1 is thickened to a higher degree of viscosity (a thickening step) to form a first printing layer 2 on the fabric 1.

[0030] The first liquid may be applied on the whole surface of the fabric 1 or a partial surface of the fabric 1 where the colorant will be later applied.

[0031] The dyeing assistants refer to auxiliary agents conventionally used in dyeing. The dyeing assistant may be one selected suitably for a used colorant from level dyeing assistants, retarding assistants, accelerating agents, mordanting agents, fixing agents, reducing agents, humectants and the like.

[0032] The level dyeing assistants and the retarding assistants may be termed as level dyeing agents and dye retardants. They are chemicals that slow down the dyeing rate to have a target medium be evenly dyed. They are mostly surfactants, among which are level dyeing agents having affinity for fibers, and level dyeing agents having affinity for dyes. The level dyeing agents and the dye retardants may include but are not necessarily limited to the examples. Other specific examples may include AMILADIN L-33 (trade name; manufactured by Dai-ichi Kogyo Seiyaku Co., Ltd.), Noigen SS (trade name; manufactured by Dai-ichi Kogyo Seiyaku Co., Ltd.), Leopol (trade name; manufactured by TAKEMOTO OIL & FAT Co., Ltd.), and Peretex (trade name; manufactured by MIYOSHI OIL & FAT CO., LTD.).

[0033] The accelerating agents are chemicals that increase the degree of dyeing power in any combinations of colorants and fibers with poor dyeing affinity. The accelerating agents may include but are not limited to sodium chloride (salt), sodium sulfate (mirabilite), and acids used to dye protein fibers with acid dyes (hydrochloric acid, sulfuric acid, acetic acid, and formic acid).

[0034] The mordanting agents are chemicals that improve the affinity of the fabric 1 for the colorant to have the colorant be more vividly color-developed. Examples of the mordanting agents may include but are not limited to alum ($\text{Al}_2(\text{SO}_4)_3 \cdot \text{K}_2\text{SO}_4 \cdot 24\text{H}_2\text{O}$), ferrous sulfate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$), chromium alum ($\text{Cr}_2(\text{SO}_4)_3 \cdot \text{K}_2\text{SO}_4 \cdot 24\text{H}_2\text{O}$), tannic acid, and Kotonol (trade name; manufactured by Moriwake Chemical Laboratory Co., Ltd.).

[0035] The fixing agents are chemicals that mediate between fibers and colorants to impart the dyeing affinity

to the fibers. Examples the fixing agents may include but are not limited to Katanol OH, tartar emetic (Antimony potassium tartrate), Fix salt L (trade name; manufactured by Fuji Chemical Industries Co., Ltd.), MC-Fix (trade name; manufactured by Matsui Chemical Co., Ltd.), Nylox 1500·1200·700·800 (trade name; manufactured by IPPOSHA OIL INDUSTRIES CO., LTD.), Silkfix 3A (trade name; manufactured by SENKA Corporation), Amigen (trade name; manufactured by Dai-ichi Kogyo Seiyaku Co., Ltd.), Chromosol SSS (trade name; manufactured by SENKA Corporation), and Han Nord Fix, Soritoru N and TKS Fix (trade name; TOKAI SEIYU KOGYO K.K.).

[0036] The reducing agents are chemicals that reduce water (hot water)-insoluble colorants such as vat dyes and sulfur dyes to impart solubility to these chemical. Examples of the reducing dyes may include but are not limited to hydrated sodium sulfite, Blankit IAN, DA, D, IN, AR (trade name; manufactured by BASF), and Rongalit FD (trade name; manufactured by BASF).

[0037] A non-limiting example of the humectants may be urea.

[0038] While the composition of the first liquid is not particularly limited in so far as it contains the dyeing assistant, the first liquid may further include, for example, a water-soluble photo-curable resin, a sizing material, a pH adjuster, a regulator of surface tension, and a preservative. A solvent usable for the first liquid may be optionally selected, non-limiting examples of which may include pure water, and water-soluble organic solvents (multivalent alcohols, monovalent alcohols, alkyl ethers of multivalent alcohols, amines). The first liquid may preferably be diluted with the solvent to be lowered in viscosity than the second liquid. This may allow the dyeing assistant to be better absorbed into the fabric 1. The first liquid may preferably have a degree of viscosity between approximately 5 mPa·s and 20 mPa·s.

[0039] The viscosity of the first liquid applied on the fabric 1 may be thickened in any manner suitable for the purpose, for example, (A) the first liquid further mixed with the water-soluble photo-curable resin may be irradiated with light, or (B) the first liquid may be heated.

[0040] Examples of the water-soluble photo-curable resin may include but are not limited to water-soluble monofunctional unsaturated ethylene monomers (for example, hydroxyl group-containing (meth) acrylates having carbon numbers of 5 to 15 [hydroxyethyl (meth) acrylate, hydroxypropyl (meth) acrylate, and 4-hydroxybutyl (meth) acrylate], N-dimethyl(meth)acrylamide, N-diethyl(meth)acrylamide, and N-hydroxyethyl(meth)acrylamide).

[0041] Methods for irradiating the liquids with light are not particularly limited. A preferable example may be one selected from light irradiators configured to emit lights of wavelengths that cause the water-soluble photo-curable resin to be cured. When a water-soluble ultraviolet-curable resin is used as the water-soluble photo-curable resin, suitable examples of the light irradiator may include a UV-LED, a metal halide lamp, a high pressure mercury

lamp, and a germicidal lamp.

[0042] Non-limiting examples of the heating means may include a radiant heating, a thermal conduction heating, and a microwave heating.

[0043] The first liquid applied on the fabric 1 may be preferable thickened after applying the first liquid on the whole fabric 1 is completed. The first liquid, however, may be more preferable thickened after applying the first liquid on each section on the fabric 1 within a predetermined time frame. As described later, this embodiment may adequately apply and thicken the first liquid by using an inkjet head including a nozzle for applying the first liquid, and a light irradiator or a heater for increasing the viscosity of the first liquid, wherein the nozzle is located at a position more forward in a main scanning direction than the light irradiator or the heater. Therefore, when such an inkjet head is used, the nozzle moves above the respective sections on the fabric 1, and each of the sections is applied with the first liquid discharged through the nozzle. Then, the light irradiator or the heater moves above these sections to thicken the first liquid discharged thereon.

[0044] The main scanning direction refers to a direction in which scans are performed by an inkjet head. The sub scanning direction refers to a direction different to the main scanning direction, specifically a direction in which an inkjet head is displaced relative to the fabric 1 at intervals between the scans. The inkjet apparatus used in this embodiment may be an apparatus of a flatbed type or a roller type.

[0045] Subsequently, in Step S2, the fabric 1 is printed by inkjet printing with a second liquid containing a colorant and a water-soluble photo-curable resin (a second printing step), and the second liquid applied on the fabric 1 is irradiated with light (a light irradiating step) to form a second printing layer 3 on the fabric 1.

[0046] The second liquid is preferably applied on the fabric 1 in a manner that any desired image can be printed thereon.

[0047] The colorant may be a dye. Examples of the dye may include disperse dyes, acid dyes, and reactive dyes.

[0048] While the composition of the second liquid is not particularly limited in so far as it contains the colorant and the water-soluble photo-curable resin, the second liquid may further contain, for example, a humectant, a pH adjuster, a regulator of surface tension, a preservative, and a dispersant. A solvent usable for the second liquid may be optionally selected, non-limiting examples of which may include pure water, and water-soluble organic solvents (multivalent alcohols, monovalent alcohols, alkyl ethers of multivalent alcohols, amines).

[0049] The water-soluble photo-curable resin and the light irradiating means are as noted previously, which will not be described again.

[0050] The second liquid applied on the fabric 1 may be preferable irradiated with light after applying the second liquid on the whole fabric 1 is completed. The second

liquid, however, may be more preferable irradiated with light for each of sections on the fabric 1 after applying the second liquid on each of sections on the fabric 1 is completed. As described later, this embodiment may adequately apply and thicken the second liquid by using an inkjet head including a nozzle for printing the second liquid, and a light irradiator for irradiating the second liquid with light, wherein the nozzle is located at a position more forward in the main scanning direction than the light irradiator. Therefore, when such an inkjet head is used, the nozzle moves above the respective sections on the fabric 1, and each of the sections is printed with the second liquid discharged through the nozzle. Then, the light irradiator moves above these sections to irradiate the second liquid with light.

[0051] In the inkjet textile printing, the colorant is preferably difficult to smear to obtain a clear and sharp image, while the dyeing assistant is preferably smeared and well-absorbed into the fabric. In this embodiment, the water-soluble photo-curable resin is mixed with the second liquid in addition to the colorant (a second printing step), and the resulting second liquid is irradiated with light (a light irradiating step) to cure the water-soluble photo-curable resin. This may thicken the second solution, thereby suppressing smearing of the colorant. In case the dyeing assistant and the colorant are applied on the fabric at once, the second liquid immediately starts to be thickened to prevent smearing of the colorant. Then, it may be difficult for the fabric to absorb the dyeing assistant sufficiently. This embodiment, however, applies the dyeing assistant on the fabric separately from and prior to the step of applying the colorant on the fabric. Hence, the dyeing assistant may be well-absorbed into the fabric. When the inkjet textile printing is performed, therefore, the coloring effect may advantageously be improved by allowing the dyeing assistant to be well-absorbed into the fabric, while the occurrence of smearing is suppressed.

[0052] The intended purpose of the pretreatment conventionally performed for textile printing may be to prevent smearing of colorants. The first printing step according to this embodiment is not performed to prevent smearing of the colorant but is performed to have the dyeing assistant be well-absorbed into the fabric. This printing step, therefore, is totally different to the pretreatment conventionally performed for textile printing. In this embodiment, the water-soluble photo-curable resin is mixed with the second liquid in addition to the colorant, and the resulting second liquid is irradiated with light to suppress smearing of the colorant. The pretreatment conventionally employed is, therefore, unnecessary.

[0053] This embodiment thickens the first liquid applied on the fabric in the first printing step prior to the second printing step. This may avoid that the colorant is dissolved in the first liquid on the fabric 1, thereby making smearing of the colorant more unlikely to occur.

[0054] Preferably, a period of time between when the fabric is printed with the first liquid in the first printing step

and when the first liquid is thickened to a higher degree of viscosity in the thickening step is greater than a period of time between when the fabric is printed with the second liquid in the second printing step and when the second liquid is irradiated with light in the light irradiating step.

[0055] This may allow the first liquid to be smeared and absorbed into the fabric 1 over a sufficiently long time, while making it difficult for the fabric 1 to be smeared with the second liquid. Thus, the dyeing assistant may be better absorbed into the fabric, while smearing of the colorant may be suppressed.

[0056] By employing an inkjet head 10 hereinafter described, Steps S1 and S2 (the first printing step, the second printing step, the thickening step, and the light irradiating step) may advantageously be performed in a structurally simplified manner.

[0057] FIG. 3 schematically illustrates the inkjet head 10 according to an embodiment of the present disclosure. As illustrated in FIG. 3, the inkjet head 10 includes: a first nozzle 13 for printing the fabric with the first liquid in the first printing step; a first light irradiator 14 for irradiating the first liquid with light in the thickening step; second nozzles 11y, 11m, 11c, and 11k (respectively for colors including but not limited to yellow, magenta, cyan, and black) for printing the fabric with the second liquid in the second printing step; and a second light irradiator 12 for irradiating the second liquid with light in the light irradiating step. The nozzle 13 is located at a position more forward in the main scanning direction than the first light irradiator 14. The second nozzles 11y, 11m, 11c, and 11k are located at positions more forward in the main scanning direction than the second light irradiator 12. The first nozzle 13 and the first light irradiator 14 are located at positions more rearward in the sub scanning direction than the second nozzles 11y, 11m, 11c and 11k, and the second light irradiator 12. An distance L between the first nozzle 13 and the first light irradiator 14 is greater than distances between the second nozzles 11y, 11m, 11c, 11k and the second light irradiator 12.

[0058] When the inkjet head 10 is used for printing, the first nozzle 13 moves above the sections on the fabric 1, applying the first liquid thereon. After the first liquid is spread, smeared and well-absorbed into the fabric 1 while the inkjet head 10 is moving over the distance L, the first light irradiator 14 moves above the sections to thicken the first liquid to a higher degree of viscosity. After the inkjet head 10 is displaced in the sub scanning direction relative to the fabric 1, the second nozzles 11y, 11m, 11c, and 11k move above the sections to apply the second liquid thereon. Then, the second light irradiator 12 almost instantly moves above the sections to thicken the second liquid to a higher degree of viscosity, thereby preventing smearing of the second liquid.

[0059] This disclosure includes the inkjet head 10 and an inkjet apparatus equipped with the inkjet head 10 in its scope.

[0060] When the first liquid on the fabric 1 is thickened by heating in the thickening step, an inkjet head including

a heater instead of the first light irradiator 14 may preferably be used as the inkjet head 10. The inkjet head according to this embodiment may preferably include: a first nozzle used to apply the first liquid in the first printing step; a heater used to heat the first liquid in the thickening step; a second nozzle used to apply the second liquid in the second printing step; and a light irradiator used to irradiate the second liquid with light in the light irradiating step, wherein the first nozzle is located at a position more forward in the main scanning direction than the heater, the second nozzle is located at a position more forward in the main scanning direction than the light irradiator, the first nozzle and the heater are located at positions more rearward in the sub scanning direction than the second nozzle and the light irradiator, and a distance between the first nozzle and the heater is greater than a distance between the second nozzle and the light irradiator. Such an inkjet head may produce the same advantageous effects as produced by the inkjet head 10.

[0061] This disclosure includes the inkjet head and an inkjet apparatus equipped with this inkjet head in its scope.

[0062] Then, in Step S3, the colorant on the fabric 1 is subjected to coloring treatment (a color developing step).

Non-limiting examples of the coloring treatment may include steaming, HT steaming, and HP steaming. A suitable one may be selected from such known methods depending on materials of a print medium and an ink to be used.

[0063] Finally, in Step S4, the surface of the fabric 1 is rinsed with cleaning liquid such as water, and then dried to remove the water-soluble photo-curable resin and the dye left unexhausted on the fabric 1 (a removing step). In case a cellulose fiber fabric is used as a medium to be printed, such a fabric is conventionally rinsed with water or hot water, and treated in a soaping bath. The fabric is then rinsed with water or hot water, and then dried.

[0064] The steps thus far described may suppress smearing of the colorant, thereby successfully printing a desired image on the fabric 1 in vivid colors.

[Additional Remarks]

[0065] An inkjet printing method according to an embodiment of the present disclosure includes: a first printing step of printing the fabric 1 by inkjet printing with a first liquid containing a dyeing assistant; a second printing step of printing on the fabric 1 by inkjet printing subsequent to the first printing step with a second liquid containing a colorant and a water-soluble photo-curable resin; and a light irradiating step of irradiating the second liquid applied on the fabric 1 with light.

[0066] The colorant is preferably difficult to smear to obtain a clear and sharp image. The dyeing assistant is preferably smeared and well-absorbed into the fabric 1. According to the configuration, the colorant in the second liquid applied on the fabric may be unlikely to smear by mixing the water-soluble photo-curable resin with the

second liquid in addition to the colorant (a second printing step) and by irradiating the second liquid with light (a light irradiating step). In case the dyeing assistant and the colorant are applied on the fabric 1 at once, it may be difficult for the fabric 1 to absorb the dyeing assistant. This configuration, however, applies the dyeing assistant on the fabric 1 separately from and prior to the step of applying the colorant to the fabric 1. Hence, the dyeing assistant may be well-absorbed into the fabric 1. The fabric 1 printed by inkjet printing, therefore, may produce an improved coloring effect, while suppressing smearing of the colorant.

[0067] The inkjet printing method according to an embodiment of the present disclosure may be provided that the first liquid applied on the fabric 1 in the first printing step is lower in viscosity than the second liquid applied on the fabric 1 in the second printing step.

[0068] The configuration may allow the dyeing assistant to be better absorbed into the fabric 1.

[0069] The inkjet printing method according to an embodiment of the present disclosure may further include a thickening step of thickening the first liquid applied on the fabric 1 in the first printing step to a higher degree of viscosity, and the thickening step is performed between the first printing step and the second printing step.

[0070] According to the configuration, by thickening the first liquid applied on the fabric 1 in the first printing step before proceeding to the second printing step, the colorant may be more difficult to smear.

[0071] The inkjet printing method according to an embodiment of the present disclosure may be further provided that the first liquid further includes a water-soluble photo-curable resin, and the thickening step further includes irradiating the first liquid applied on the fabric 1 in the first printing step with light.

[0072] According to the configuration, the thickening step may successfully increase the first liquid in viscosity.

[0073] The inkjet printing method according to some embodiments of the present disclosure may be provided further that the thickening step includes heating the first liquid applied on the fabric 1 in the first printing step.

[0074] According to the configuration, the thickening step may successfully increase the first liquid in viscosity.

[0075] The inkjet printing method according to an embodiment of the present disclosure may be further characterized in that a period of time between when the fabric 1 is printed with the first liquid in the first printing step and when the first liquid is thickened in the thickening step is greater than a period of time between when the fabric 1 is printed with the second liquid in the second printing step and when the second liquid is irradiated with light in the light irradiating step.

[0076] According to the configuration, the dyeing assistant may be better absorbed into the fabric 1.

[0077] The inkjet printing method may preferably include performing the first printing step, the thickening step, the second printing step, and the light irradiating step by using the inkjet head 10, the inkjet head 10 in-

cluding: a first nozzle used to apply the first liquid in the first printing step; a first light irradiator used to irradiate the first liquid with light in the thickening step; a second nozzle used to apply the second liquid in the second printing step; and a second light irradiator used to irradiate the second liquid with light in the light irradiating step, wherein the first nozzle is located at a position more forward in the main scanning direction than the first light irradiator, the second nozzle is located at a position more forward in the main scanning direction than the second light irradiator, the first nozzle and the first light irradiator are located at positions more rearward in the sub scanning direction than the second nozzle and the second light irradiator, and a distance between the first nozzle and the first light irradiator is greater than a distance between the second nozzle and the second light irradiator.

[0078] According to the configuration, the first printing step, thickening step, second printing step, and light irradiating step may be adequately and conveniently performed by using a single inkjet head. Specifically, the inkjet head 10 is structured to be adequate for the order relation among the first printing step, the thickening step, the second printing step, and light irradiating step, and time intervals to be set between the first printing step and the thickening step, and between the second printing step and the light irradiating step. When the fabric 1 is printed by inkjet printing, a simplified structure may advantageously achieve an improved coloring effect, while suppressing the occurrence of smearing.

[0079] The inkjet printing method may further include performing the first printing step, the thickening step, the second printing step, and the light irradiating step by using an inkjet head, the inkjet head including: a first nozzle used to apply the first liquid in the first printing step; a heater used to heat the first liquid in the thickening step; a second nozzle used to apply the second liquid in the second printing step; and a light irradiator used to irradiate the second liquid with light in the light irradiating step, wherein the first nozzle is located at a position more forward in the main scanning direction than the heater, the second nozzle is located at a position more forward in the main scanning direction than the light irradiator, the first nozzle and the heater are located at positions more rearward in the sub scanning direction than the second nozzle and the light irradiator, and a distance between the first nozzle and the heater is greater than a distance between the second nozzle and the light irradiator.

[0080] According to the configuration, the first printing step, the thickening step, the second printing step, and the light irradiating step may be adequately and conveniently performed by using a single inkjet head. Specifically, this inkjet head is structured to be adequate for the order relation among the first printing step, the thickening step, the second printing step, and the light irradiating step, and time intervals to be set between the first printing step and the thickening step, and between the second printing step and the light irradiating step. When the fabric 1 is printed by inkjet printing, a simplified structure may

advantageously achieve an improved coloring effect, while suppressing the occurrence of smearing.

[0081] This disclosure is not necessarily limited to the embodiment described so far and may be carried out in many other forms. The technical scope of this disclosure encompasses any modifications within the technical scope disclosed herein that is defined by the appended claims and embodiments obtained by variously combining the technical means disclosed herein. The entire contents of any patent and non-patent literatures disclosed in this description are incorporated herein by reference.

INDUSTRIAL APPLICABILITY

[0082] This disclosure is advantageously applicable to various technical fields including the textile industry in which inkjet textile printing is employed.

Claims

1. An inkjet printing method, comprising:
 - a first printing step of printing a fabric by inkjet printing with a first liquid comprising a dyeing assistant;
 - a second printing step of printing the fabric by inkjet printing subsequent to the first printing step with a second liquid comprising a colorant and a water-soluble photo-curable resin; and
 - a light irradiating step of irradiating the second liquid applied on the fabric in the second printing step with light.
2. The inkjet printing method as set forth in claim 1, wherein
 - the first liquid applied on the fabric in the first printing step is lower in viscosity than the second liquid applied on the fabric in the second printing step.
3. The inkjet printing method as set forth in claim 1 or 2, further comprising:
 - a thickening step of thickening the first liquid applied on the fabric in the first printing step to a higher degree of viscosity, wherein the thickening step is performed subsequent to the first printing step and prior to the second printing step.
4. The inkjet printing method as set forth in claim 3, wherein
 - the first liquid further comprises: a water-soluble photo-curable resin, and
 - the thickening step further comprises: irradiating the first liquid applied on the fabric in the first printing step with light.
5. The inkjet printing method as set forth in claim 3, wherein
 - the thickening step comprises: heating the first liquid applied on the fabric in the first printing step.
6. The inkjet printing method as set forth in claim 3, wherein
 - a period of time between when the fabric is printed with the first liquid in the first printing step and when the first liquid is thickened in the thickening step is greater than a period of time between when the fabric is printed with the second liquid in the second printing step and when the second liquid is irradiated with light in the light irradiating step.
7. The inkjet printing method as set forth in claim 4, wherein
 - a period of time between when the fabric is printed with the first liquid in the first printing step and when the first liquid is thickened in the thickening step is greater than a period of time between when the fabric is printed with the second liquid in the second printing step and when the second liquid is irradiated with light in the light irradiating step.
8. The inkjet printing method as set forth in claim 5, wherein
 - a period of time between when the fabric is printed with the first liquid in the first printing step and when the first liquid is thickened in the thickening step is greater than a period of time between when the fabric is printed with the second liquid in the second printing step and when the second liquid is irradiated with light in the light irradiating step.
9. The inkjet printing method as set forth in claim 4, comprising:
 - performing the first printing step, the thickening step, the second printing step, and the light irradiating step by using an inkjet head, and
 - the inkjet head comprising:
 - a first nozzle that applies the first liquid in the first printing step;
 - a first light irradiator that irradiates with light in the thickening step;
 - a second nozzle that applies the second liquid in the second printing step; and
 - a second light irradiator that irradiates with light in the light irradiating step, wherein
 - the first nozzle is located at a position more forward in a main scanning direction than the first light irradiator,
 - the second nozzle is located at a position more forward in the main scanning direction than the second light irradiator,
 - the first nozzle and the first light irradiator

are located at positions more rearward in a sub scanning direction than the second nozzle and the second light irradiator, and a distance between the first nozzle and the first light irradiator is greater than a distance between the second nozzle and the second light irradiator. 5

10. The inkjet printing method as set forth in claim 5, comprising: 10

performing the first printing step, the thickening step, the second printing step, and the light irradiating step by using an inkjet head, and the inkjet head including: 15

a first nozzle that applies the first liquid in the first printing step;
a heater that heats the first liquid in the thickening step; 20
a second nozzle that applies the second liquid in the second printing step; and
a light irradiator that irradiates with light in the light irradiating step, wherein
the first nozzle is located at a position more forward in a main scanning direction than the heater, 25
the second nozzle is located at a position more forward in the main scanning direction than the light irradiator, 30
the first nozzle and the heater are located at positions more rearward in a sub scanning direction than the second nozzle and the light irradiator, and
a distance between the first nozzle and the heater is greater than a distance between the second nozzle and the light irradiator. 35

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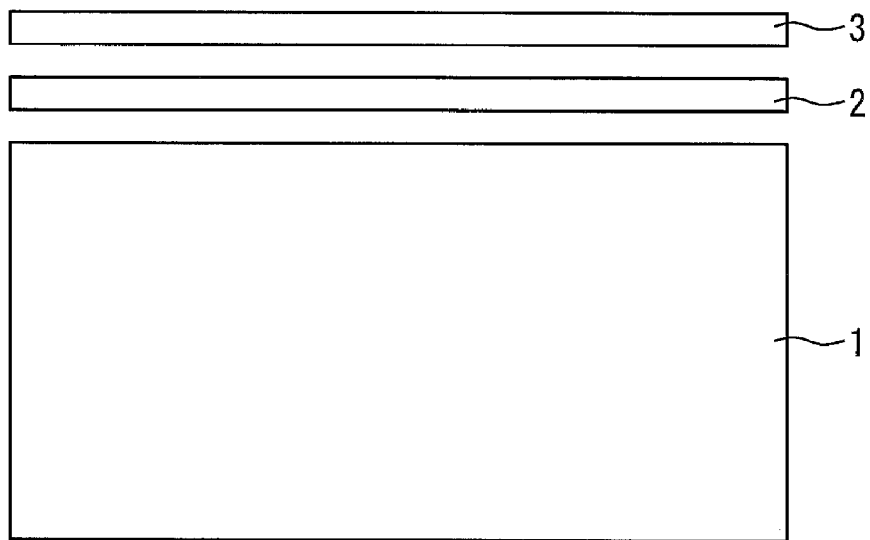


FIG. 1

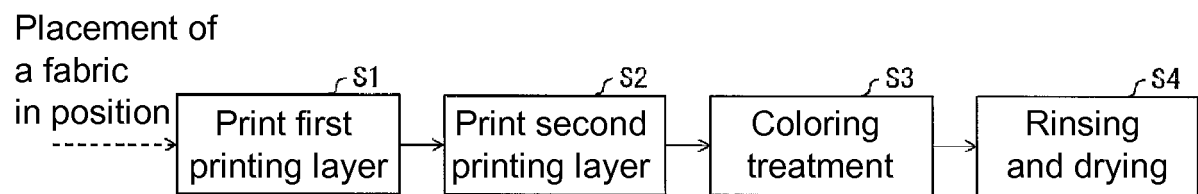


FIG. 2

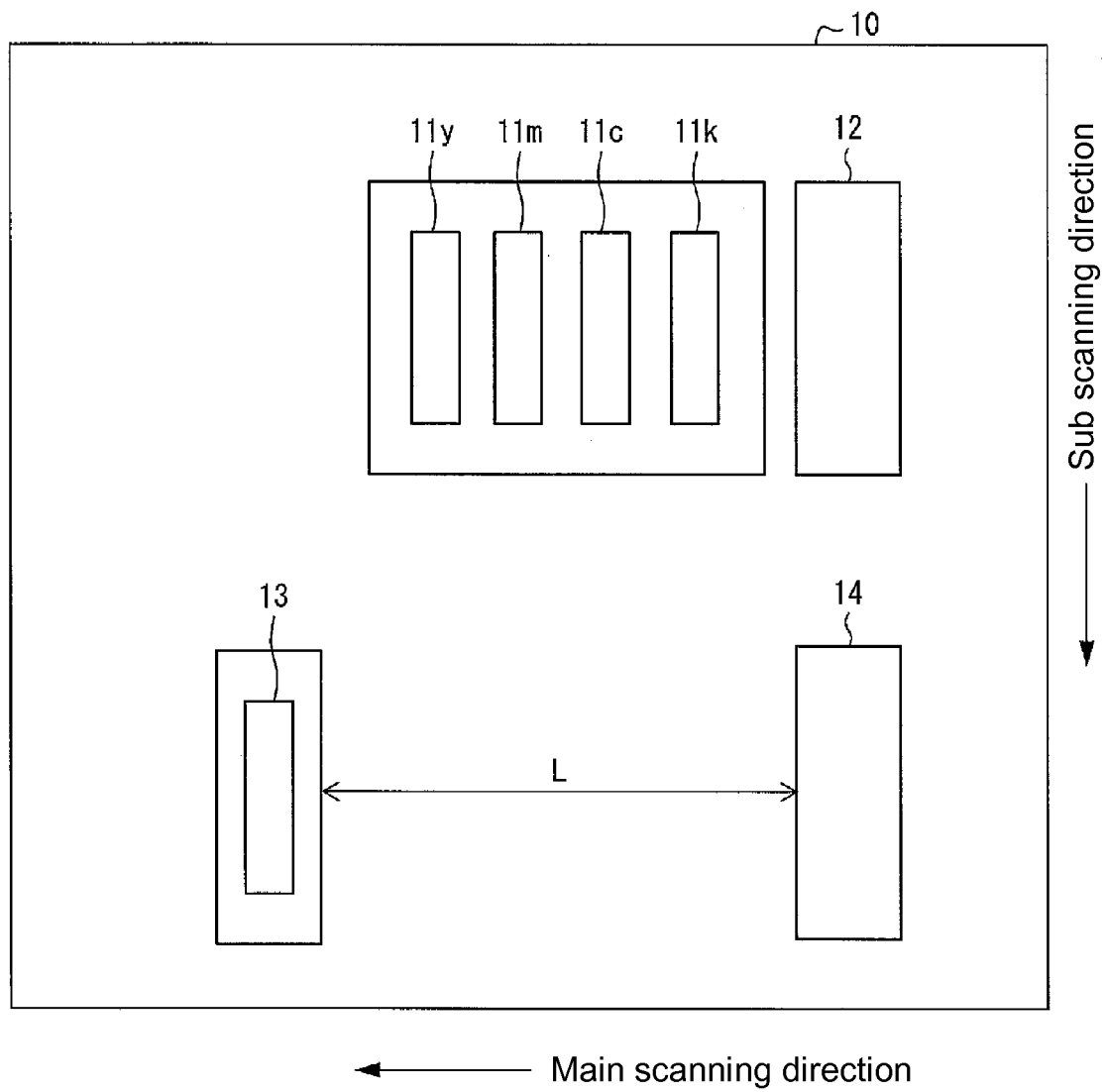


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/051454

A. CLASSIFICATION OF SUBJECT MATTER

D06P5/00(2006.01)i, B41J2/01(2006.01)i, B41M5/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D06P5/00, B41J2/01, B41M5/00

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015

Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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.
Y	JP 2006-144180 A (Konica Minolta Holdings, Inc.), 08 June 2006 (08.06.2006), claims; paragraphs [0028] to [0029]; example 1; paragraph [0080] (Family: none)	1-10
Y	JP 2006-124842 A (Konica Minolta Holdings, Inc.), 18 May 2006 (18.05.2006), claims; paragraphs [0021], [0048] to [0049]; examples (Family: none)	1-10

☒ 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
09 April 2015 (09.04.15)Date of mailing of the international search report
21 April 2015 (21.04.15)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/051454

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2010-174391 A (Konica Minolta IJ Technologies, Inc.), 12 August 2010 (12.08.2010), claims; examples (Family: none)	1-10
Y	JP 2005-232633 A (Canon Electronics Inc.), 02 September 2005 (02.09.2005), claims (Family: none)	1-10

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006144180 A [0004]