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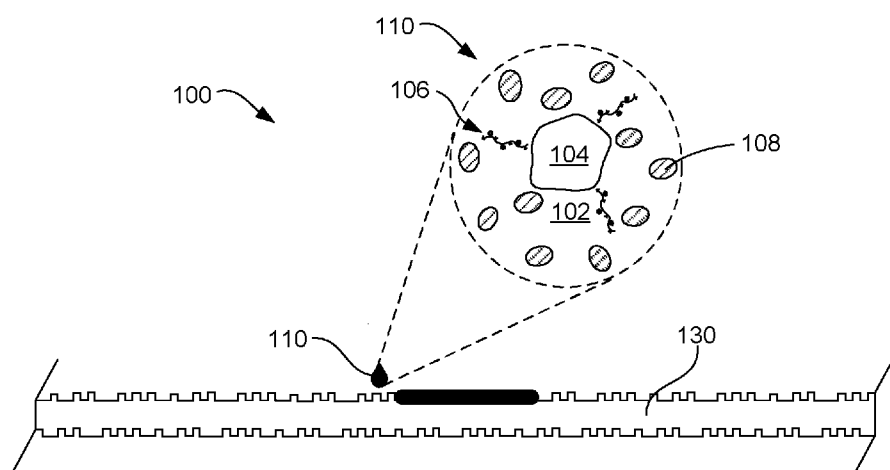


FIG. 1

(57) Abstract: A textile printing system can include an ink composition and a fabric substrate. The ink composition can include water, organic co-solvent, from 0.5 wt% to 10 wt% pigment, wherein the pigment has a dispersant associated with a surface thereof, and from 0.5 wt% to 20 wt% latex particles including styrene (meth)acrylic polymer having an acid number from 0 mg KOH/g to 60 mg KOH/g and a glass transition temperature from -30° C to 50° C. The latex particles are uncrosslinked.

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TEXTILE PRINTING

BACKGROUND

[0001] Inkjet printing has become a popular way of recording images on various media. Some of the reasons include low printer noise, variable content recording, capability of high speed recording, and multi-color recording. These advantages can be obtained at a relatively low price to consumers. As the popularity of inkjet printing increases, the types of use also increase providing demand for new ink compositions. In one example, textile printing can have various applications including the creation of signs, banners, artwork, apparel, wall coverings, window coverings, upholstery, pillows, blankets, flags, tote bags, clothing, etc. However, the permanence of printed ink on textiles can be an issue.

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BREIF DESCRIPTION OF DRAWINGS

[0002] FIG. 1 schematically depicts an example textile printing system including an ink composition and a fabric substrate in accordance with the present disclosure;

[0003] FIG. 2 schematically depicts an example textile printing system including an ink composition, a fabric substrate, an inkjet printhead, and a heat curing device in accordance with the present disclosure; and

[0004] FIG. 3 provides a flow diagram for an example method of printing textiles in accordance with the present disclosure.

DETAILED DESCRIPTION

[0005] The present disclosure is drawn to textile printing systems and methods.

In one example, a textile printing system includes an ink composition, including water, organic co-solvent, from 0.5 wt% to 10 wt% pigment with a dispersant associated with a surface thereof, and from 0.5 wt% to 20 wt% latex particles including styrene (meth)acrylic polymer having an acid number from 0 mg KOH/g to 60 mg KOH/g and a glass transition temperature from -30° C to 50° C. The latex particles in this example are uncrosslinked. The textile printing system also includes a fabric substrate, e.g., cotton, polyester, nylon, silk, or a blend thereof. In one example, the dispersant may also include a styrene (meth)acrylic polymer with an acid number greater than the acid number of the latex particles. The styrene (meth)acrylic polymer of the latex polymer can have an acid number from about 20 mg KOH/g to about 55 mg KOH/g. The latex particles can have an average particle size from 75 nm to 350 nm. In one example, the styrene (meth)acrylic polymer includes, based on a total weight of the latex particles, from 10 wt% to 35 wt% styrene moieties, and from 65 wt% to 90 wt% of (meth)acrylic moieties. The (meth)acrylic moieties can include two or more of 2-ethylhexyl acrylate, acrylic acid, methyl methacrylate, n-butyl acrylate, iso-butyl acrylate, and tert-butyl acrylate. In another example, the (meth)acrylic moieties can include 2-ethylhexyl acrylate at a total 2-ethylhexyl acrylate to styrene weight ratio of 2:1 to 1:2. In still another example, the (meth)acrylic moieties can include one or more isomer of butyl acrylate at a total butyl acrylate to styrene weight ratio of 2:1 to 1:2.

[0006] In another example, a method of textile printing includes ejecting an ink composition onto a fabric substrate. The ink composition includes water, organic co-solvent, from 0.5 wt% to 10 wt% pigment dispersant associated with a surface thereof, and from 0.5 wt% to 20 wt% latex particles including styrene (meth)acrylic polymer having an acid number from 0 mg KOH/g to 60 mg KOH/g and a glass transition temperature from -30° C to 50° C. The latex particles in this example are uncrosslinked. The styrene (meth)acrylic polymer can have an acid number from about 20 mg KOH/g to about 55 mg KOH/g and/or an average particle size from 75 nm to 350 nm. The styrene (meth)acrylic polymer can include, based on a total weight of the latex particles,

from 10 wt% to 35 wt% styrene moieties and from 65 wt% to 90 wt% of (meth)acrylic moieties. In further detail, the method can further include curing the ink composition on the fabric substrate at a temperature from 100 °C to 200 °C for from 30 seconds to 5 minutes.

5 **[0007]** In another example, a textile printing system includes a fabric substrate, an inkjet printer to eject an ink composition on the fabric substrate, and a heat curing device to apply heat to the ink composition after application onto the fabric substrate. The ink composition includes water, organic co-solvent, from 0.5 wt% to 10 wt% pigment with dispersant associated with a surface thereof, and from 0.5 wt% to 20 wt%
10 latex particles including styrene (meth)acrylic polymer having an acid number from 0 mg KOH/g to 60 mg KOH/g and a glass transition temperature from -30° C to 50° C. The latex particles in this example are uncrosslinked. In one example, the heat curing device can be to apply heat at a temperature from 100 °C to 200 °C for a period of 30 seconds to 5 minutes.

15 **[0008]** It is noted that when discussing the textile printing systems or the methods of textile printing herein, these discussions can be considered applicable to one another whether or not they are explicitly discussed in the context of that example. Thus, for example, when discussing an organic co-solvent related to the textile printing systems, such disclosure is also relevant to and directly supported in the context of the methods
20 of textile printing, and *vice versa*. It is also understood that terms used herein will take on their ordinary meaning in the relevant technical field unless specified otherwise. In some instances, there are terms defined more specifically throughout the specification or included at the end of the present specification, and thus, these terms have a meaning as described herein.

25 **[0009]** Turning now to more specific detail regarding the textile printing systems, in FIG. 1, an example textile printing system 100 is shown which includes a fabric substrate 130 and an ink composition 110. The ink composition includes water and organic co-solvent (shown collectively as liquid vehicle 102), pigment 104 with dispersant 106 associated with a surface of the pigment. The ink composition also
30 includes latex particles 108. The dispersant can be associated with the pigment by adsorption, ionic attraction, or by covalent attachment thereto. The latex particles can

include styrene (meth)acrylic polymer having an acid number from 0 mg KOH/g to 60 mg KOH/g and a glass transition temperature from -30° C to 50° C, for example.

[0010] In certain more specific examples, the latex particles 108 can be uncrosslinked. The term “uncrosslinked” means that the polymer chains are devoid of
5 chemical crosslinkers or crosslinking groups that connect individual polymer strands to one another, thus partially contributing to some the lower glass transition temperatures for the latex particles described herein. The glass transition temperature, for example, can be from -30° C to 50° C, from -20° C to 40° C, from 0° C to 50° C, from 0° C to 40° C, or from 5° C to 40° C, for example. The latex particles can also have a D50 particle
10 size from 75 nm to 350 nm, an acid number from 0 mg KOH/g to 60 mg KOH/g, and/or an acid number from 0 mg KOH/g to 60 mg KOH/g, and a glass transition temperature from -30° C to 50° C. The latex particles can have a D50 particle size from 75 nm to 350 nm, from 100 nm to 300 nm, from 100 nm to 250 nm, or from 150 nm to 350 nm, for example. The acid number of the latex particles can be from 0 mg KOH/g to 60 mg
15 KOH/g, from 0 mg KOH/g to 45 mg KOH/g, from 0 mg KOH/g to 30 mg KOH/g, from 2 mg KOH/g to 20 mg KOH/g, or from 4 mg KOH/g to 15 mg KOH/g, for example. The glass transition temperature from -30° C to 50° C, from -20° C to 40° C, from 0° C to 50° C, from 0° C to 40° C, or from 5° C to 40° C, for example. In certain more specific examples, the latex particles can have a weight average molecular weight from 30,000
20 Mw to 500,000 Mw, from 50,000 Mw to 300,000 Mw, or from 75,000 Mw to 200,000 Mw.

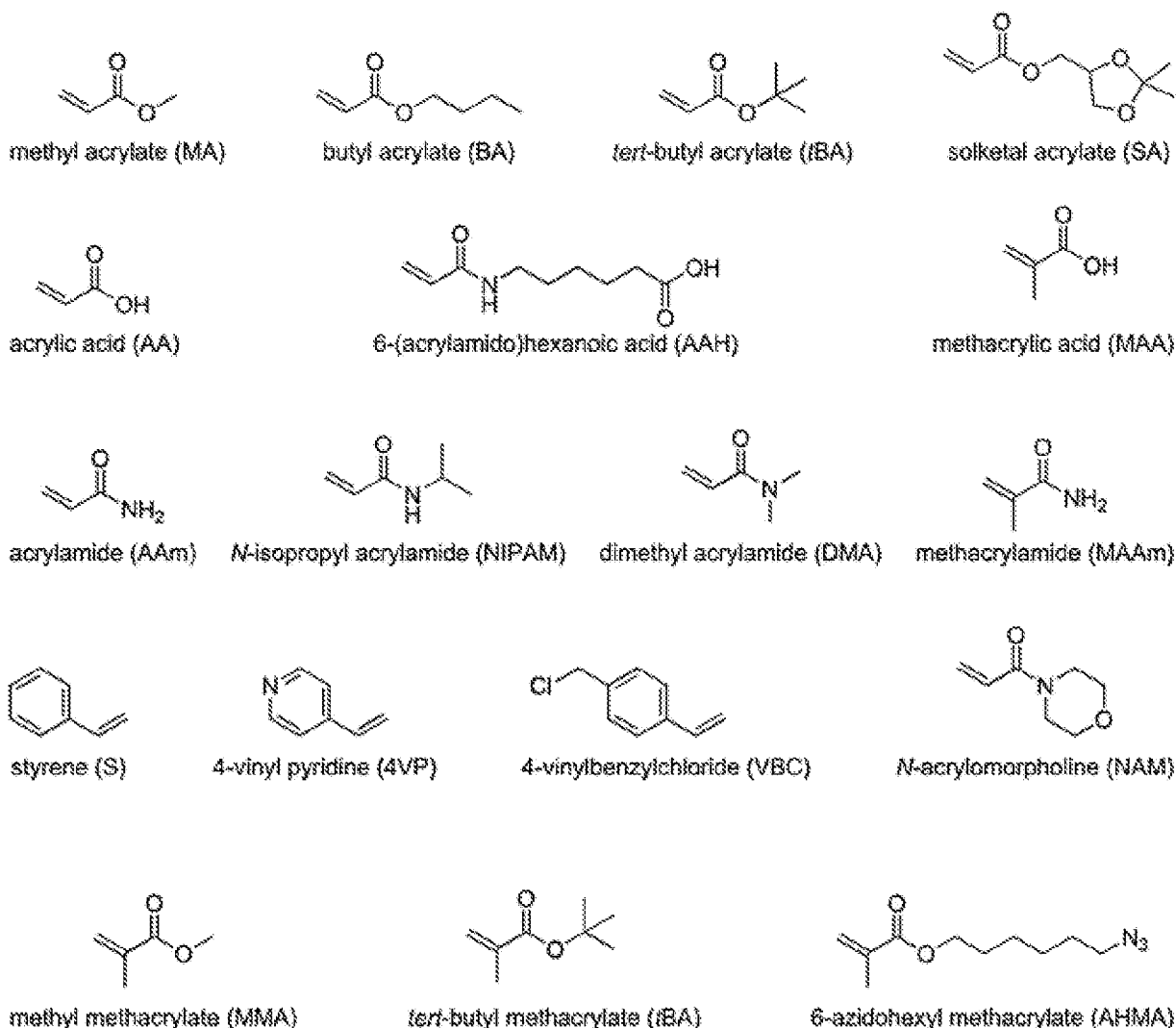
[0011] Monomers used to prepare the styrene (meth)acrylic polymers can include classes of styrene monomers, and classes of (meth)acrylic monomers, but can also include other types of co-monomers in addition to these two specific types of monomers. Examples of monomers that can be used include monoacrylates,
25 diacrylates, or polyfunctional alkoxyated or polyalkoxyated acrylic monomers comprising one or more di- or tri-acrylates. Suitable monoacrylates are, for example, cyclohexyl acrylate, 2-ethoxy ethyl acrylate, 2-methoxy ethyl acrylate, 2(2-ethoxyethoxy)ethyl acrylate, stearyl acrylate, tetrahydrofurfuryl acrylate, octyl acrylate, lauryl acrylate, behenyl acrylate, 2-phenoxy ethyl acrylate, tertiary butyl acrylate,
30 glycidyl acrylate, isodecyl acrylate, benzyl acrylate, hexyl acrylate, isooctyl acrylate, isobornyl acrylate, butanediol monoacrylate, ethoxylated phenol monoacrylate,

oxyethylated phenol acrylate, monomethoxy hexanediol acrylate, beta-carboxy ethyl acrylate, dicyclopentyl acrylate, carbonyl acrylate, octyl decyl acrylate, ethoxylated nonylphenol acrylate, hydroxyethyl acrylate, hydroxyethyl methacrylate, and the like.

Suitable polyfunctional alkoxyated or polyalkoxyated acrylates are, for example,

5 alkoxyated, ethoxylated, or propoxylated, variants of the following: neopentyl glycol diacrylates, butanediol diacrylates, trimethylolpropane triacrylates, glyceryl triacrylates, 1,3-butylene glycol diacrylate, 1,4-butanediol diacrylate, diethylene glycol diacrylate, 1,6-hexanediol diacrylate, tetraethylene glycol diacrylate, triethylene glycol diacrylate, tripropylene glycol diacrylate, polybutanediol diacrylate, polyethylene glycol diacrylate, 10 propoxylated neopentyl glycol diacrylate, ethoxylated neopentyl glycol diacrylate, polybutadiene diacrylate, and the like. The monomer can be, for example, propoxylated neopentyl glycol diacrylate, such as, for example, SR-9003 (Sartomer Co., Inc., Exton, Pa.). Suitable reactive monomers are likewise commercially available from, for example, Sartomer Co., Inc., Henkel Corp., Radcure Specialties, and the like.

15 **[0012]** The chemical structure of a few monomers that can be used is shown as follows:



[0013] Various emulsion polymerization emulsifiers can also be included to assist with polymerizing the monomers in an emulsion polymerization process, such as a fatty acid ether sulfate, a lauryl ether sulfate, or other similar emulsifier. The emulsifier may be included in an amount from 0.1 wt% to 5 wt%, for example. The emulsifier can be used to obtain a desired particle size of the latex particles, and can further contribute to the surface tension of the latex. For example, the latex particles can exhibit a surface tension from 35 dynes/cm to 65 dynes/cm, from 40 dynes/cm to 60 dynes/cm, or from 45 dynes/cm to about 55 dynes/cm. The emulsion polymerization is conducted in accordance with polymerization processes, such as, for example, a semi-batch process. The latex can be synthesized by free radical initiated polymerization using a free radical initiator, e.g., initiator including a “per” compound such as a diazo compound,

persulfate, per-oxygen, or the like, or a thermal initiator, for example.

[0014] Thus, when the ink compositions 110, which includes the latex particles 108 such as those shown in Tables 1A and 1B, for example, are printed on various types of fabrics 130, e.g., cotton, nylon, polyester, cotton/polyester blend, etc., and
5 exposed to durability challenges, such as washfastness, e.g., five (5) standard washing machine cycles using warm water and a standard clothing detergent (e.g., Tide® available from Proctor and Gamble, Cincinnati, OH, USA), acceptable optical density retention and other color properties of the printed inks can be the result. Additionally, ink compositions with these latex particles can also exhibit good stability over time as well
10 as good thermal inkjet printhead performance such as high drop weight, high drop velocity, good fogation, and acceptable “Turn On Energy” or TOE curve values

[0015] Turning to further detail regarding other components of the ink compositions that can be used for the systems and methods described herein, the pigment can be any of a number of pigments of any of a number of primary or
15 secondary colors, or can be black or white, for example. More specifically, colors can include cyan, magenta, yellow, red, blue, violet, red, orange, green, etc. In one example, the ink composition can be a black ink with a carbon black pigment. In another example, the ink composition can be a cyan or green ink with a copper phthalocyanine pigment, e.g., Pigment Blue 15:0, Pigment Blue 15:1; Pigment Blue 15:3, Pigment Blue
20 15:4, Pigment Green 7, Pigment Green 36, etc. In another example, the ink composition can be a magenta ink with a quinacridone pigment or a co-crystal of quinacridone pigments. Example quinacridone pigments that can be utilized can include PR122, PR192, PR202, PR206, PR207, PR209, PO48, PO49, PV19, PV42, or the like. These pigments tend to be magenta, red, orange, violet, or other similar colors. In one
25 example, the quinacridone pigment can be PR122, PR202, PV19, or a combination thereof. In another example, the ink composition can be a yellow ink with an azo pigment, e.g., PY74 and PY155. Other examples of pigments include the following, which are available from BASF Corp.: PALIOGEN® Orange, HELIOGEN® Blue L 6901F, HELIOGEN® Blue NBD 7010, HELIOGEN® Blue K 7090, HELIOGEN® Blue L 7101F, PALIOGEN® Blue L 6470, HELIOGEN® Green K 8683, HELIOGEN® Green L 9140, CHROMOPHTAL® Yellow 3G, CHROMOPHTAL® Yellow GR,

CHROMOPHTAL® Yellow 8G, IGRAZIN® Yellow 5GT, and IGRALITE® Rubine 4BL.

The following pigments are available from Degussa Corp.: Color Black FWI, Color Black FW2, Color Black FW2V, Color Black 18, Color Black, FW200, Color Black 5150, Color Black S160, and Color Black 5170. The following black pigments are available from

5 Cabot Corp.: REGAL® 400R, REGAL® 330R, REGAL® 660R, MOGUL® L, BLACK PEARLS® L, MONARCH® 1400, MONARCH® 1300, MONARCH® 1100, MONARCH® 1000, MONARCH® 900, MONARCH® 880, MONARCH® 800, and MONARCH® 700.

The following pigments are available from Orion Engineered Carbons GMBH:

PRINTEX® U, PRINTEX® V, PRINTEX® 140U, PRINTEX® 140V, PRINTEX® 35,

10 Color Black FW 200, Color Black FW 2, Color Black FW 2V, Color Black FW 1, Color Black FW 18, Color Black S 160, Color Black S 170, Special Black 6, Special Black 5, Special Black 4A, and Special Black 4. The following pigment is available from DuPont:

TI-PURE® R-101. The following pigments are available from Heubach: MONASTRAL® Magenta, MONASTRAL® Scarlet, MONASTRAL® Violet R, MONASTRAL® Red B, and

15 MONASTRAL® Violet Maroon B. The following pigments are available from Clariant:

DALAMAR® Yellow YT-858-D, Permanent Yellow GR, Permanent Yellow G, Permanent Yellow DHG, Permanent Yellow NCG-71, Permanent Yellow GG, Hansa Yellow RA, Hansa Brilliant Yellow 5GX-02, Hansa Yellow-X, NOVOPERM® Yellow HR, NOVOPERM® Yellow FGL, Hansa Brilliant Yellow 10GX, Permanent Yellow G3R-01,

20 HOSTAPERM® Yellow H4G, HOSTAPERM® Yellow H3G, HOSTAPERM® Orange GR, HOSTAPERM® Scarlet GO, and Permanent Rubine F6B. The following pigments are available from Sun Chemical: QUINDO® Magenta, INDOFAST® Brilliant Scarlet, QUINDO® Red R6700, QUINDO® Red R6713, INDOFAST® Violet, L74-1357 Yellow, L75-1331 Yellow, L75-2577 Yellow, and LHD9303 Black. The following pigments are

are available from Sun Chemical: QUINDO® Magenta, INDOFAST® Brilliant Scarlet, QUINDO® Red R6700, QUINDO® Red R6713, INDOFAST® Violet, L74-1357 Yellow, L75-1331 Yellow, L75-2577 Yellow, and LHD9303 Black. The following pigments are

25 available from Birla Carbon: RAVEN® 7000, RAVEN® 5750, RAVEN® 5250, RAVEN® 5000 Ultra® II, RAVEN® 2000, RAVEN® 1500, RAVEN® 1250, RAVEN® 1200, RAVEN® 1190 Ultra®, RAVEN® 1170, RAVEN® 1255, RAVEN® 1080, and RAVEN® 1060. The following pigments are available from Mitsubishi Chemical Corp.: No. 25, No.

33, No. 40, No. 47, No. 52, No. 900, No. 2300, MCF-88, MA600, MA7, MA8, and

30 MA100. The colorant may be a white pigment, such as titanium dioxide, or other inorganic pigments such as zinc oxide and iron oxide.

[0016] Specific other examples of a cyan color pigment may include C.I. Pigment Blue -1, -2, -3, -15, -15:1, -15:2, -15:3, -15:4, -16, -22, and -60; magenta color pigment may include C.I. Pigment Red -5, -7, -12, -48, -48:1, -57, -112, -122, -123, -146, -168, -177, -184, -202, and C.I. Pigment Violet-19; yellow pigment may include C.I. Pigment Yellow -1, -2, -3, -12, -13, -14, -16, -17, -73, -74, -75, -83, -93, -95, -97, -98, -114, -128, -129, -138, -151, -154, and -180. Black pigment may include carbon black pigment or organic black pigment such as aniline black, e.g., C.I. Pigment Black 1. While several examples have been given herein, it is to be understood that any other pigment can be used that is useful in color modification, or dye may even be used in addition to the pigment.

[0017] Furthermore, pigments and dispersants are described separately herein, but there are pigments that are commercially available which include both the pigment and a dispersant suitable for ink composition formulation. Specific examples of pigment dispersions that can be used, which include both pigment solids and dispersant are provided by example, as follows: HPC-K048 carbon black dispersion from DIC Corporation (Japan), HSKBPG-11-CF carbon black dispersion from Dom Pedro (USA), HPC-C070 cyan pigment dispersion from DIC, CABOJET® 250C cyan pigment dispersion from Cabot Corporation (USA), 17-SE-126 cyan pigment dispersion from Dom Pedro, HPF-M046 magenta pigment dispersion from DIC, CABOJET® 265M magenta pigment dispersion from Cabot, HPJ-Y001 yellow pigment dispersion from DIC, 16-SE-96 yellow pigment dispersion from Dom Pedro, or Emacol SF Yellow AE2060F yellow pigment dispersion from Sanyo (Japan).

[0018] Thus, the pigment(s) can be dispersed by a dispersant that is adsorbed or ionically attracted to a surface of the pigment, or can be covalently attached to a surface of the pigment as a self-dispersed pigment. In one example, the dispersant can be an acrylic dispersant, such as a styrene (meth)acrylate dispersant, or other dispersant suitable for keeping the pigment suspended in the liquid vehicle. In one example, the styrene (meth)acrylate dispersant can be used, as it can promote π -stacking between the aromatic ring of the dispersant and various types of pigments. In one example, the styrene (meth)acrylate dispersant can have a weight average molecular weight from 4,000 Mw to 30,000 Mw. In another example, the styrene-acrylic dispersant can have a

weight average molecular weight of 8,000 Mw to 28,000 Mw, from 12,000 Mw to 25,000 Mw, from 15,000 Mw to 25,000 Mw, from 15,000 Mw to 20,000 Mw, or about 17,000 Mw. Regarding the acid number, the styrene (meth)acrylate dispersant can have an acid number from 100 to 350, from 120 to 350, from 150 to 300, from 180 to 250, or about 214, for example. Example commercially available styrene-acrylic dispersants can include Joncryl® 671, Joncryl® 71, Joncryl® 96, Joncryl® 680, Joncryl® 683, Joncryl® 678, Joncryl® 690, Joncryl® 296, Joncryl® 671, Joncryl® 696 or Joncryl® ECO 675 (all available from BASF Corp., Germany).

[0019] The term “(meth)acrylic” refers to monomers, copolymerized monomers, etc., that can either be acrylate or methacrylate (or a combination of both), or acrylic acid or methacrylic acid (or a combination of both), as the acid or salt/ester form can be a function of pH. Furthermore, even if the monomer used to form the polymer was in the form of a (meth)acrylic acid during preparation, pH modifications during preparation or subsequently when added to an ink composition can impact the nature of the moiety as well (acid form vs. salt or ester form). Thus, a monomer or a moiety of a polymer described as (meth)acrylic should not be read so rigidly as to not consider relative pH levels, ester chemistry, and other general organic chemistry concepts.

[0020] The ink compositions of the present disclosure can be formulated to include a liquid vehicle, which can include the water content, e.g., 60 wt% to 90 wt% or from 75 wt% to 85 wt%, as well as organic co-solvent, e.g., from 4 wt% to 30 wt%, from 6 wt% to 20 wt%, or from 8 wt% to 15 wt%. Other liquid vehicle components can also be included, such as surfactant, antibacterial agent, other colorant, etc. However, as part of the ink composition used in the systems and methods described herein, the pigment, dispersant, and the latex particles can be included or carried by the liquid vehicle components. Suitable pH ranges for the ink composition can be from pH 6 to pH 10, from pH 7 to pH 10, from pH 7.5 to pH 10, from pH 8 to pH 10, 6 to pH 9, from pH 7 to pH 9, from pH 7.5 to pH 9, etc.

[0021] In further detail regarding the liquid vehicle, the co-solvent(s) can be present and can include any co-solvent or combination of co-solvents that is compatible with the pigment, dispersant, and latex particles. Examples of suitable classes of co-solvents include polar solvents, such as alcohols, amides, esters, ketones, lactones,

and ethers. In additional detail, solvents that can be used can include aliphatic alcohols, aromatic alcohols, diols, glycol ethers, polyglycol ethers, caprolactams, formamides, acetamides, and long chain alcohols. Examples of such compounds include primary aliphatic alcohols, secondary aliphatic alcohols, 1,2-alcohols, 1,3-alcohols, 1,5-alcohols, ethylene glycol alkyl ethers, propylene glycol alkyl ethers, higher homologs (C₆-C₁₂) of polyethylene glycol alkyl ethers, N-alkyl caprolactams, unsubstituted caprolactams, both substituted and unsubstituted formamides, both substituted and unsubstituted acetamides, and the like. More specific examples of organic solvents can include 2-pyrrolidone, 2-ethyl-2-(hydroxymethyl)-1, 3-propane diol (EPHD), glycerol, dimethyl sulfoxide, sulfolane, glycol ethers, alkyldiols such as 1,2-hexanediol, and/or ethoxylated glycerols such as LEG-1, etc.

[0022] The liquid vehicle can also include surfactant and/or emulsifier. In general, the surfactant can be water soluble and may include alkyl polyethylene oxides, alkyl phenyl polyethylene oxides, polyethylene oxide (PEO) block copolymers, acetylenic PEO, PEO esters, PEO amines, PEO amides, dimethicone copolyols, ethoxylated surfactants, alcohol ethoxylated surfactants, fluorosurfactants, and mixtures thereof. In some examples, the surfactant can include a nonionic surfactant, such as a Surfynol® surfactant, e.g., Surfynol® 440 (from Evonik, Germany), or a Tergitol™ surfactant, e.g., Tergitol™ TMN-6 (from Dow Chemical, USA). In another example, the surfactant can include an anionic surfactant, such as a phosphate ester of a C₁₀ to C₂₀ alcohol or a polyethylene glycol (3) oleyl mono/di phosphate, e.g., Crodafos® N3A (from Croda International PLC, United Kingdom). The surfactant or combinations of surfactants, if present, can be included in the ink composition at from about 0.01 wt% to about 5 wt% and, in some examples, can be present at from about 0.05 wt% to about 3 wt% of the ink compositions.

[0023] Consistent with the formulations of the present disclosure, various other additives may be included to provide desired properties of the ink composition for specific applications. Examples of these additives are those added to inhibit the growth of harmful microorganisms. These additives may be biocides, fungicides, and other microbial agents, which are routinely used in ink formulations. Examples of suitable microbial agents include, but are not limited to, Acticide®, e.g., Acticide® B20 (Thor

Specialties Inc.), Nuosept™ (Nudex, Inc.), Ucarcide™ (Union carbide Corp.), Vancide® (R.T. Vanderbilt Co.), Proxel™ (ICI America), and combinations thereof. Sequestering agents, such as EDTA (ethylene diamine tetra acetic acid) or trisodium salt of methylglycinediacetic acid, may be included to eliminate the deleterious effects of heavy metal impurities, and buffer solutions may be used to control the pH of the ink. Viscosity modifiers and buffers may also be present, as well as other additives known to those skilled in the art to modify properties of the ink as desired.

[0024] As shown in FIG. 2, the ink compositions 100 can be printed on fabric substrates 110. For example, the ink compositions can be printed from an inkjet pen 120 which includes an ejector 122, such as a thermal inkjet ejector, for example. These ink compositions can be suitable for printing on many types of textiles, but can be particularly acceptable on treated or untreated natural fabric textile substrates, e.g., wool, cotton, silk, linen, jute, flax, hemp, rayon fibers, thermoplastic aliphatic polymeric fibers derived from renewable resources (e.g. cornstarch, tapioca products, sugarcane), etc. Treated fabrics can include a coating, for example, such as a coating including a cationic component such as calcium salt, magnesium salt, cationic polymer, etc. These types of substrates can provide acceptable optical density (OD) and/or washfastness properties. The term "washfastness" can be defined as the OD or delta E (ΔE) that is retained after five (5) standard washing machine cycles using warm water and a standard clothing detergent (e.g., Tide® available from Proctor and Gamble, Cincinnati, OH, USA). Essentially, by measuring OD and/or $L^*a^*b^*$ both before and after washing, ΔOD and ΔE value can be determined, which is essentially a quantitative way of expressing the difference between the OD and/or $L^*a^*b^*$ prior to and after undergoing the washing cycles. Thus, the lower the ΔOD and ΔE values, the better. In further detail, ΔE is a single number that represents the "distance" between two colors, which in accordance with the present disclosure, is the color (or black) prior to washing and the modified color (or modified black) after washing.

[0025] Colors, for example, can be expressed as CIELAB values. It is noted that color differences may not be symmetrical going in both directions (pre-washing to post washing vs. post-washing to pre-washing). Using the CIE 1976 definition, the color difference can be measured and the ΔE value calculated based on subtracting the pre-

washing color values of L^* , a^* , and b^* from the post-washing color values of L^* , a^* , and b^* . Those values can then be squared, and then a square root of the sum can be determined to arrive at the ΔE value. The 1976 standard can be referred to herein as

" ΔE_{CIE} ." The CIE definition was modified in 1994 to address some perceptual non-

uniformities, retaining the $L^*a^*b^*$ color space, but modifying to define the $L^*a^*b^*$ color space with differences in lightness (L^*), chroma (C^*), and hue (h^*) calculated from

$L^*a^*b^*$ coordinates. Then in 2000, the CIEDE standard was established to further resolve the perceptual non-uniformities by adding five corrections, namely i) hue

rotation (R_T) to deal with the problematic blue region at hue angles of about 275° , ii)

compensation for neutral colors or the primed values in the L^*C^*h differences, iii)

compensation for lightness (S_L), iv) compensation for chroma (S_C), and v) compensation for hue (S_H). The 2000 modification can be referred to herein as " ΔE_{2000} ." In accordance

with examples of the present disclosure, ΔE value can be determined using the CIE

definition established in 1976, 1994, and 2000 to demonstrate washfastness. However,

in the examples of the present disclosure, ΔE_{CIE} and ΔE_{2000} are used.

[0026] In further detail regarding the fabric substrates, the fabric can include a substrate, and in some examples can be treated, such as with a coating that includes a calcium salt, a magnesium salt, a cationic polymer, or a combination of a calcium or magnesium salt and cationic polymer. Fabric substrates can include substrates that

have fibers that may be natural and/or synthetic, but in some examples, the fabric is particularly useful with natural fabric substrates. The fabric substrate can include, for

example, a textile, a cloth, a fabric material, fabric clothing, or other fabric product suitable for applying ink, and the fabric substrate can have any of a number of fabric

structures. The term "fabric structure" is intended to include structures that can have

warp and weft, and/or can be woven, non-woven, knitted, tufted, crocheted, knotted,

and pressured, for example. The terms "warp" and "weft" have their ordinary meaning in

the textile arts, as used herein, e.g., warp refers to lengthwise or longitudinal yarns on a loom, while weft refers to crosswise or transverse yarns on a loom.

[0027] It is notable that the term "fabric substrate" does not include materials

commonly known as any kind of paper (even though paper can include multiple types of natural and synthetic fibers or mixtures of both types of fibers). Fabric substrates can

include textiles in filament form, textiles in the form of fabric material, or textiles in the form of fabric that has been crafted into a finished article (e.g. clothing, blankets, tablecloths, napkins, towels, bedding material, curtains, carpet, handbags, shoes, banners, signs, flags, etc.). In some examples, the fabric substrate can have a woven, knitted, non-woven, or tufted fabric structure. In one example, the fabric substrate can be a woven fabric where warp yarns and weft yarns can be mutually positioned at an angle of about 90°. This woven fabric can include but is not limited to, fabric with a plain weave structure, fabric with a twill weave structure where the twill weave produces diagonal lines on a face of the fabric, or a satin weave. In another example, the fabric substrate can be a knitted fabric with a loop structure. The loop structure can be a warp-knit fabric, a weft-knit fabric, or a combination thereof. A warp-knit fabric refers to every loop in a fabric structure that can be formed from a separate yarn mainly introduced in a longitudinal fabric direction. A weft-knit fabric refers to loops of one row of fabric that can be formed from the same yarn. In a further example, the fabric substrate can be a non-woven fabric. For example, the non-woven fabric can be a flexible fabric that can include a plurality of fibers or filaments that are one or both bonded together and interlocked together by a chemical treatment process (e.g., a solvent treatment), a mechanical treatment process (e.g., embossing), a thermal treatment process, or a combination of two or more of these processes.

[0028] Regardless of the structure, in one example, the fabric substrate can include natural fibers, synthetic fibers, or a combination thereof. Exemplary natural fibers can include, but are not limited to, wool, cotton, silk, linen, jute, flax, hemp, rayon fibers, thermoplastic aliphatic polymeric fibers derived from renewable resources (e.g. cornstarch, tapioca products, sugarcane), or a combination thereof. In another example, the fabric substrate can include synthetic fibers. Exemplary synthetic fibers can include polymeric fibers such as, polyvinyl chloride (PVC) fibers, PVC-free fibers made of polyester, polyamide, polyimide, polyacrylic, polypropylene, polyethylene, polyurethane, polystyrene, polyaramid (e.g., Kevlar®) polytetrafluoroethylene (Teflon®) (both trademarks of E. I. du Pont de Nemours Company, Delaware), fiberglass, polytrimethylene, polycarbonate, polyethylene terephthalate, polyester terephthalate, polybutylene terephthalate, or a combination thereof. In some examples, the synthetic

fiber can be a modified fiber from the above-listed polymers. The term “modified fiber” refers to one or both of the polymeric fiber and the fabric as a whole having undergone a chemical or physical process such as, but not limited to, one or more of a copolymerization with monomers of other polymers, a chemical grafting reaction to contact a chemical functional group with one or both the polymeric fiber and a surface of the fabric, a plasma treatment, a solvent treatment, acid etching, or a biological treatment, an enzyme treatment, or antimicrobial treatment to prevent biological degradation. The term “PVC-free fibers” as used herein means that no polyvinyl chloride (PVC) polymer or vinyl chloride monomer units are in the fibers.

[0029] As previously mentioned, the fabric substrate can be a combination of fiber types, e.g. a combination of any natural fiber with another natural fiber, any natural fiber with a synthetic fiber, a synthetic fiber with another synthetic fiber, or mixtures of multiple types of natural fibers and/or synthetic fibers in any of the above combinations. In some examples, the fabric substrate can include natural fiber and synthetic fiber. The amount of each fiber type can vary. For example, the amount of the natural fiber can vary from about 5 wt% to about 95 wt% and the amount of synthetic fiber can range from about 5 wt% to 95 wt%. In yet another example, the amount of the natural fiber can vary from about 10 wt% to 80 wt% and the synthetic fiber can be present from about 20 wt% to about 90 wt%. In other examples, the amount of the natural fiber can be about 10 wt% to 90 wt% and the amount of synthetic fiber can also be about 10 wt% to about 90 wt%. Likewise the ratio of natural fiber to synthetic fiber in the fabric substrate can vary. For example, the ratio of natural fiber to synthetic fiber can be 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, 1:7, 1:8, 1:9, 1:10, 1:11, 1:12, 1:13, 1:14, 1:15, 1:16, 1:17, 1:18, 1:19, 1:20, or *vice versa*.

[0030] In one example, the fabric substrate can have a basis weight ranging from about 10 gsm to about 500 gsm. In another example, the fabric substrate can have a basis weight ranging from about 50 gsm to about 400 gsm. In other examples, the fabric substrate can have a basis weight ranging from about 100 gsm to about 300 gsm, from about 75 gsm to about 250 gsm, from about 125 gsm to about 300 gsm, or from about 150 gsm to about 350 gsm.

[0031] In addition the fabric substrate can contain additives including, but not

limited to, one or more of colorant (e.g., pigments, dyes, and tints), antistatic agents, brightening agents, nucleating agents, antioxidants, UV stabilizers, fillers and lubricants, for example. Alternatively, the fabric substrate may be pre-treated in a solution containing the substances listed above before applying other treatments or coating layers.

[0032] In another example, and as set forth in FIG. 3, a method 300 of textile printing includes ejecting 310 an ink composition onto a fabric substrate. The ink composition includes water, organic co-solvent, from 0.5 wt% to 10 wt% pigment dispersant associated with a surface thereof, and from 0.5 wt% to 20 wt% latex particles including styrene (meth)acrylic polymer having an acid number from 0 mg KOH/g to 60 mg KOH/g and a glass transition temperature from -30° C to 50° C. The styrene (meth)acrylic polymer can have an acid number from about 20 mg KOH/g to about 55 mg KOH/g and/or an average particle size from 75 nm to 350 nm. The styrene (meth)acrylic polymer can include, based on a total weight of the latex particles, from 10 wt% to 35 wt% styrene moieties and from 65 wt% to 90 wt% of (meth)acrylic moieties. In further detail, the method can further include curing the ink composition on the fabric substrate at a temperature from 100 °C to 200 °C for from 30 seconds to 5 minutes.

[0033] It is noted that, as used in this specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the content clearly dictates otherwise.

[0034] As used herein, the term "about" is used to provide flexibility to a numerical range endpoint by providing that a given value may be "a little above" or "a little below" the endpoint. The degree of flexibility of this term can be dictated by the particular variable and would be within the knowledge of those skilled in the art to determine based on experience and the associated description herein.

[0035] The term "acid value" or "acid number" refers to the mass of potassium hydroxide (KOH) in milligrams that can be used to neutralize one gram of substance (mg KOH/g), such as the latex polymers disclosed herein. This value can be determined, in one example, by dissolving or dispersing a known quantity of a material in organic solvent and then titrating with a solution of potassium hydroxide (KOH) of known concentration for measurement.

[0036] “Glass transition temperature” or “Tg,” can be calculated by the Fox equation: copolymer $T_g = 1 / (W_a / (T_g A) + W_b / (T_g B) + \dots)$ where W_a = weight fraction of monomer A in the copolymer and $T_g A$ is the homopolymer T_g value of monomer A, W_b = weight fraction of monomer B and $T_g B$ is the homopolymer T_g value of monomer B, etc.

5 [0037] “D50” particle size is defined as the particle size at which about half of the particles are larger than the D50 particle size and about half of the other particles are smaller than the D50 particle size (by weight based on the metal particle content of the particulate build material). As used herein, particle size with respect to the latex particles can be based on volume of the particle size normalized to a spherical shape
10 for diameter measurement, for example. Particle size can be collected using a Malvern Zetasizer, for example. Likewise, the “D95” is defined as the particle size at which about 5 wt% of the particles are larger than the D95 particle size and about 95 wt% of the remaining particles are smaller than the D95 particle size. Particle size information can also be determined and/or verified using a scanning electron microscope (SEM).

15 [0038] As used herein, a plurality of items, structural elements, compositional elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. Thus, no individual member of such list should be construed as a *de facto* equivalent of any other member of the same
20 list solely based on their presentation in a common group without indications to the contrary.

[0039] Concentrations, dimensions, amounts, and other numerical data may be presented herein in a range format. It is to be understood that such range format is used merely for convenience and brevity and should be interpreted flexibly to include not only
25 the numerical values explicitly recited as the limits of the range, but also to include all the individual numerical values or sub-ranges encompassed within that range as if each numerical value and sub-range is explicitly recited. For example, a weight ratio range of about 1 wt% to about 20 wt% should be interpreted to include not only the explicitly recited limits of about 1 wt% and about 20 wt%, but also to include individual weights
30 such as 2 wt%, 11 wt%, 14 wt%, and sub-ranges such as 10 wt% to 20 wt%, 5 wt% to 15 wt%, etc.

EXAMPLES

[0040] The following examples illustrate the technology of the present disclosure.

5 However, it is to be understood that the following is merely illustrative of the methods and systems herein. Numerous modifications and alternative methods and systems may be devised without departing from the present disclosure. Thus, while the technology has been described above with particularity, the following provides further detail in connection with what are presently deemed to be the acceptable examples.

10 Example 1 - *Preparation of Latex Particles to Include in Ink Compositions for Textile Printing Systems or Methods of Textile Printing (Latex 1)*

[0041] A suspension of styrene (18.222 g), sodium persulfate (SPS) (0.5 g), 2-ethylhexyl acrylate (EHA) (32.242 g), sodium dodecyl sulfate (SDS) (2.0 g), acryl acid
15 (AA) (6.304 g), BA (28.031 g), and MMA (10.957 g) in DI water (147 g) was well mixed under high speed for 2-3 hours. The suspension was transferred into a three-neck flask equipped with condenser thermometer and N₂ inlet under 80 °C water-bath within 3 hours. The suspension was stirred at 85 °C for another 2 hours. The suspension was then cooled to room temperature and another 67 g of DI water was added. The
20 suspension was then neutralized by 50% NaOH (7.348 g) at room temperature. The particle size was 104.3 nm, the solids content was 28.29 wt%, the acid number was about 50 mg KOH/g, and the glass transition temperature (T_g) was -0.58 °C.

25 Example 2 - *Preparation of Latex Particles to Include in Ink Compositions for Textile Printing Systems or Methods of Textile Printing (Latex 2)*

[0042] A suspension of styrene (25.214 g), sodium persulfate (SPS) (0.5 g), 2-ethylhexyl acrylate (EHA) (15.933 g), sodium dodecyl sulfate (SDS) (2.0 g), acryl acid
(AA) (3.115 g), BA (17.731 g) and MMA (34.653 g) in DI water (149 g) was well mixed
30 under high speed for 2-3 hours. The suspension was transferred into a three-neck flask equipped with condenser thermometer and N₂ inlet under 80 °C water-bath within 3 hours. The suspension was stirred at 85 °C for another 2 hours. The suspension was

then cooled to room temperature and another 65 g of DI water was added. The suspension was then neutralized by 50% NaOH (3.631 g) at room temperature. The particle size was 83.69 nm, the solid content was 28.92 wt%, the acid number was about 25 mg KOH/g, and the glass transition temperature (T_g) was 40 °C.

5

Example 3 - *Preparation of Latex Particles to Include in Ink Compositions for Textile Printing Systems or Methods of Textile Printing (Latex 3)*

[0043] A suspension of styrene (19.892 g), sodium persulfate (SPS) (0.5 g), 2-ethylhexyl acrylate (EHA) (21.118 g), sodium dodecyl sulfate (SDS) (2.0 g), acryl acid (AA) (3.166 g), BA (19.584 g) and MMA (32.534 g) in DI water (148 g) was well mixed under high speed for 2-3 hours. The suspension was transferred into a three-neck flask equipped with condenser thermometer and N₂ inlet under 80 °C water-bath within 3 hours. The suspension was stirred at 85 °C for another 2 hours. The suspension was then cooled to room temperature and another 66 g of DI water was added. The suspension was then neutralized by 50% NaOH (3.69 g) at room temperature. The particle size was 86.85 nm, the solid content was 28.59 wt%, the acid number was about 25 mg KOH/g, and the glass transition temperature was 28 °C.

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Example 4 - *Preparation of Latex Particles to Include in Ink Compositions for Textile Printing Systems or Methods of Textile Printing (Latex 4-10)*

[0044] Latexes 4-10 were prepared in a manner similar to that described in Examples 1-3, except different concentrations of the various components were used, as shown in Tables 1A and 1B, as follows (which also includes Latexes 1-3 for comparison):

25

Table 1A – Polymerized Uncrosslinked Latexes (Parts by Weight)

Latex Component	Category	Latex 1	Latex 2	Latex 3	Latex 4	Latex 5
Styrene	Monomer	18.222	25.214	19.892	24.718	20.053
2-Ethylhexyl Acrylate (EHA)	Monomer	32.242	15.933	21.118	15.620	21.288
Acrylic Acid	Monomer	6.304	3.115	3.166	6.719	6.243
Methyl	Monomer	10.957	34.653	32.534	32.273	28.938

Methacrylate (MMA)						
Butyl Acrylate (BA)	Monomer	28.031	17.731	19.584	17.382	19.742
Sodium Persulfate (SPS)	Initiator	0.5	0.5	0.5	0.5	0.5
Sodium Dodecyl Sulfate (SDS)	Emulsifier	2	2	2	2	2
Latex Particle Properties						
Acid Number (approx.) (mg KOH/g)		50	25	25	50	50
Glass Transition Temperature (°C Tg)		-0.58	39.59	28.31	40.66	27.82
D50 Particles Size (nm)		104.3	83.69	86.85	131.20	145.7

Table 1B – Polymerized Uncrosslinked Latexes (Parts by Weight)

Latex Component	Category	Latex 6	Latex 7	Latex 8	Latex 9	Latex 10
Styrene	Monomer	18.730	21.302	13.763	18.496	21.190
2-Ethylhexyl Acrylate (EHA)	Monomer	24.855	28.268	41.745	24.545	28.120
Acrylic Acid	Monomer	6.480	6.448	6.121	3.199	3.115
Methyl Methacrylate (MMA)	Monomer	22.525	12.809	5.675	26.692	16.564
Butyl Acrylate (BA)	Monomer	23.050	26.214	29.034	22.762	26.077
Sodium Persulfate (SPS)	Initiator	0.5	0.5	0.5	0.5	0.5
Sodium Dodecyl Sulfate (SDS)	Emulsifier	2	2	2	2	2
Latex Particle Properties						
Acid Number (approx.) (mg KOH/g)		50	50	50	25	25
Glass Transition Temperature, Tg (°C)		18.01	9.09	-15.17	18.85	9.47
D50 Particles Size (nm)		291.9	113	112.5	89.65	95.66

Example 5 - Ink Compositions

[0045] Ink Compositions are prepared using latex particles, namely Latex 1 to Latex 10 in accordance with Tables 1A and 1B. The ink compositions are formulated as shown in Table 2, which shows the compositional components and relative weight percentages (to 100 wt%), as follows:

Table 2 – Ink Compositions

Ingredients	Category	Amount (wt%)
Glycerol	Organic Co-solvent	6
LEG-1	Organic-Co-solvent	1
Crodafos® N3 Acid	Surfactant	0.5
Surfynol® 440	Surfactant	0.3
Acticide® B20	Biocide	0.22
Latex Particles	Binder	6
Magenta Pigment (dispersed with styrene-acrylic polymer dispersant)	Pigment Colorant	3
Water	Solvent	Balance

Crodafos™ is available from Croda® International Plc. (Great Britain).

Surfynol® is available from Evonik, (Canada).

Acticide® is available from Thor Specialties, Inc. (USA).

Example 6 – Heat-cured Ink Composition Durability on Fabric Substrates

[0046] Several prints were prepared by applying the magenta ink composition of Table 2 as durability plots at 3 dots per pixel (dpp) on fabric substrates, which in this example was a gray cotton fabric substrate. The printed samples were not overprinted with a crosslinker, so the durability data provided is for printed ink compositions on a fabric substrate without crosslinking. Furthermore, the latex particles also are not crosslinked during preparation. After printing, the ink compositions were cured on the respective fabrics at 80 °C and 150 °C for 3 minutes. Inks cured at 80 °C provided acceptable durability results in several instances, but across the board, the images were not as durable as when cured at 150 °C. After curing, initial optical densities (OD) and L*a*b* values were recorded, the various printed fabrics were exposed to 5 washing machine complete wash cycles using conventional washing machines at 40 °C with detergent, e.g., Tide®, with air drying in between wash cycles. After 5 washes, the OD and L*a*b* were recorded a second time for comparison.

Table 3 – *Durability of Magenta Ink Composition printed and Heat-Cured on Cotton Gray Fabric Substrate*

PU-ID	80 °C Curing				150 °C Curing			
	Initial OD	OD 5 wash	% Δ OD	ΔE_{CIE}	Initial OD	OD 5 wash	% Δ OD	ΔE_{CIE}
Latex 1	0.982	0.778	-20.8	11.26	0.990	0.915	-7.6	4.11
Latex 2	0.978	0.850	-13.0	7.11	0.969	0.895	-7.6	4.36
Latex 3	0.955	0.855	-10.4	5.80	0.953	0.901	-5.5	2.58
Latex 4	0.735	0.631	-14.2	5.96	0.668	0.658	-1.5	2.52
Latex 5	0.929	0.787	-15.2	6.74	0.860	0.825	-4.1	1.65
Latex 7	0.721	0.653	-9.4	4.39	0.690	0.668	-3.2	2.58
Latex 8	0.955	0.837	-12.4	6.88	0.953	0.918	-3.7	2.10
Latex 9	0.840	0.745	-11.0	4.59	0.878	0.845	-3.8	1.85

5 **[0047]** As can be seen from the data collected above, most of the latex-based ink compositions printed on gray cotton fabric substrate showed good durability even without external crosslinkers, with a few showing excellent durability which is similar to commercially available Jantex™ polymers, available from JANTEX INKS, (USA), which includes melamine crosslinkers that can be toxic.

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Example 7 – Latex Particle Accelerated Shelf Life (ASL) Stability

15 **[0048]** ASL data was collected for samples of the latex particles, as shown in Tables 4. The ASL data was collected for the ink compositions before and after 1 week of storage at 60 °C. The % Δ data below relates to a comparison prior to ASL storage and after 1 week of storage, where Viscosity refers to the fluid viscosity of the dispersion at 6 wt% latex particles in the ink composition); pH refers to the pH of the ink composition; Mv refers to Volume Averaged Particle Size; and D95 refers to the 95 Percentile Particle Size.

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Table 4 – ASL of Latex Particles

PUD-ID	% Δ Viscosity	% Δ Mv	% Δ Mv	% Δ D95
Latex 1	2.6	-0.08	2.9	3.9
Latex 2	0.0	-0.07	20.1	12.9
Latex 3	0.0	-0.06	-20.2	-15.0
Latex 4	-5.6	0.01	10.3	9.8

Latex 5	3.1	0.00	22.9	26.5
Latex 7	0.0	0.03	2.9	3.9
Latex 8	0.0	-0.02	-3.0	-6.7
Latex 9	0.0	0.12	-1.8	-6.1

[0049] As can be seen in Table 4, about half of latex-based inks showed good ASL stability, while just a few showed substantial particle increases after 1 week of ASL conditions, e.g., 60 °C. Several Latexes were reasonable or good in most or all

5 categories evaluated for ASL stability.

Example 8 – Ink Composition Printability Performance

[0050] The various ink compositions which included the latex particles identified in Table 5 below were evaluated for performance from a thermal inkjet pen (A3410, available from HP, Inc.). The data was collected according to the following procedures:

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[0051] Decap is determined using the indicated time (1 second or 7 seconds) where nozzles remain open (uncapped), and then the number of lines missing during a print event are recorded. Thus, the lower the number the better for decap performance

[0052] Percent (%) Missing Nozzles is calculated based on the number of nozzles incapable of firing at the beginning of a jetting sequence as a percentage of the total number of nozzles on an inkjet printhead attempting to fire. Thus, the lower the percentage number, the better the Percent Missing Nozzles value.

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[0053] Drop Weight (DW) is an average drop weight in nanograms (ng) across the number of nozzles fired measured using a burst mode or firing at 0.75 Joules.

[0054] Drop Weight 2,000 (DW 2K) is measured using a 2-drop mode of firing, firing 2,000 drops and then measuring/calculating the average ink composition drop weight in nanograms (ng).

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[0055] Drop Volume (DV) refers to an average velocity of the drop as initially fired from the thermal inkjet nozzles.

[0056] Decel refers to the loss in drop velocity after 5 seconds of ink composition firing.

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[0057] Turn On Energy (TOE) Curve refers to the energy used to generate consistent ink composition firing.

Table 5 – Thermal Inkjet Print Performance

PUD-ID in Ink	Decap (1s)	Decap (7s)	% Missing Nozzles	DW (ng)	DW 2K (ng)	DV (m/s)	Decel	TOE Curve
Latex 1	23	26	2.1	9.9	8.0	8.6	0.3	Good
Latex 2	11	18	0.5	9.8	8.0	9.0	0	Good
Latex 3	9	12	0.0	9.8	8.6	8.1	0.2	Good
Latex 4	-	-	85.4	-	-	-	-	Acceptable (Low DW)
Latex 5	23	50	84.4	9	-	5.1	0.5	Acceptable (Low DW)
Latex 7	-	-	85.4	5.7	-	5.7	0.5	Acceptable (Low DW)
Latex 8	15	26	80.2	6.0	1.0	5.0	0.5	Acceptable (Low DW)
Latex 9	14	16	7.3	8.2	2.4	6.2	0.5	Acceptable (Low DW)
Latex 10	12	18	5.2	8.9	2.0	6.6	0.5	Acceptable (Low DW)

[0058] As can be seen in Table 5, many of the latexes showed reasonable or good print performance from a thermal inkjet printhead using varied testing protocols, with Latexes 2 and 3 providing particularly good results when combining both Decap and TOE Curve performance. Some of the ink compositions had acceptable or reasonable TOE Curve data, but the drop weight was lower than with respect to Latexes 1-3, for example. TOE Curve data is considered Acceptable or Good when lower levels of energy are used to achieve higher drop weights (DW) as measured in nanograms (ng). For example, achieving a drop weight (DW) of 9.5 ng or above at an energy level 0.75 Joule may be considered "Good" TOE (with DW getting larger with more energy input until the curve flattens out). Achieving a drop weight (DW) of 5.0 ng or above at an energy level 0.75 Joule may be considered "Acceptable" TOE (with DW getting larger with more energy input until the curve flattens out). In further detail, however, lower drop weights (DW) below 9.5 ng or even below 5 ng at 0.75 Joules may provide for a "Good" TOE as long as the drop weights continue to get larger as the energy increases and then flatten out at an acceptable drop weight. Achieving a drop weight below 5.0 ng at an energy level of 0.75 Joule may be considered "Good" TOE (with DW getting larger

with more energy input until the curve flattens out, as long as the drop weight is acceptable for inkjet printing applications).

[0059] While the present technology has been described with reference to certain
5 examples, those skilled in the art will appreciate that various modifications, changes, omissions, and substitutions can be made without departing from the disclosure. It is intended, therefore, that the disclosure be limited only by the scope of the following claims.

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CLAIMS

What Is Claimed Is:

- 5 1. A textile printing system, comprising:
an ink composition, including:
 water,
 organic co-solvent,
 from 0.5 wt% to 10 wt% pigment, wherein the pigment has a dispersant
10 associated with a surface thereof, and
 from 0.5 wt% to 20 wt% latex particles including styrene (meth)acrylic
 polymer having an acid number from 0 mg KOH/g to 60 mg KOH/g
 and a glass transition temperature from -30° C to 50° C, wherein
 the latex particles are uncrosslinked; and
15 a fabric substrate.
2. The textile printing system of claim 1, wherein the dispersant is also styrene
(meth)acrylic polymer, and the dispersant has an acid number greater than the acid
number of the latex particles.
- 20 3. The textile printing system of claim 1, wherein the styrene (meth)acrylic
polymer of the latex particles have an acid number from about 20 mg KOH/g to about
55 mg KOH/g.
- 25 4. The textile printing system of claim 1, wherein the latex particles have an
average particle size from 75 nm to 350 nm.
5. The textile printing system of claim 1, wherein the styrene (meth)acrylic
polymer includes, based on a total weight of the latex particles, from 10 wt% to 35 wt%
30 styrene moieties, and from 65 wt% to 90 wt% of (meth)acrylic moieties.

6. The textile printing system of claim 5, wherein the (meth)acrylic moieties includes two or more of 2-ethylhexyl acrylate, acrylic acid, methyl methacrylate, n-butyl acrylate, iso-butyl acrylate, and tert-butyl acrylate.

5 7. The textile printing system of claim 5, wherein the (meth)acrylic moieties include 2-ethylhexyl acrylate at a total 2-ethylhexyl acrylate to styrene weight ratio of 2:1 to 1:2.

10 8. The textile printing system of claim 5, wherein the (meth)acrylic moieties includes one or more isomer of butyl acrylate at a total butyl acrylate to styrene weight ratio of 2:1 to 1:2.

15 9. The textile printing system of claim 1, wherein the fabric substrate includes cotton, polyester, nylon, silk, or a blend thereof.

 10. A method of textile printing, comprising ejecting an ink composition onto a fabric substrate, wherein the ink composition comprises:

 water,

 organic co-solvent,

20 from 0.5 wt% to 10 wt% pigment, wherein the pigment has a dispersant associated with a surface thereof, and

 from 0.5 wt% to 20 wt% latex particles including styrene (meth)acrylic polymer having an acid number from 0 mg KOH/g to 60 mg KOH/g and a glass transition temperature from -30° C to 50° C, wherein
25 the latex particles are uncrosslinked.

 11. The method of claim 10, wherein the styrene (meth)acrylic polymer has an acid number from about 20 mg KOH/g to about 55 mg KOH/g and an average particle size from 75 nm to 350 nm.

12. The method of claim 10, wherein the styrene (meth)acrylic polymer includes, based on a total weight of the latex particles, from 10 wt% to 35 wt% styrene moieties, and from 65 wt% to 90 wt% of (meth)acrylic moieties.

5 13. The method of claim 10, further comprising curing the ink composition on the fabric substrate at a temperature from 100 °C to 200 °C for from 30 seconds to 5 minutes.

10 14. A textile printing system, comprising:
a fabric substrate;
an inkjet printer to eject an ink composition on the fabric substrate, the ink composition, comprising:
water,
organic co-solvent,
15 from 0.5 wt% to 10 wt% pigment, wherein the pigment has a dispersant associated with a surface thereof, and
from 0.5 wt% to 20 wt% latex particles including styrene (meth)acrylic polymer having an acid number from 0 mg KOH/g to 60 mg KOH/g and a glass transition temperature from -30° C to 50° C, wherein
20 the latex particles are uncrosslinked;
a heat curing device to apply heat the ink composition after application onto the fabric substrate.

25 15. The textile printing system of claim 14, the heat curing device to apply heat a temperature from 100 °C to 200 °C for a period of 30 seconds to 5 minutes.

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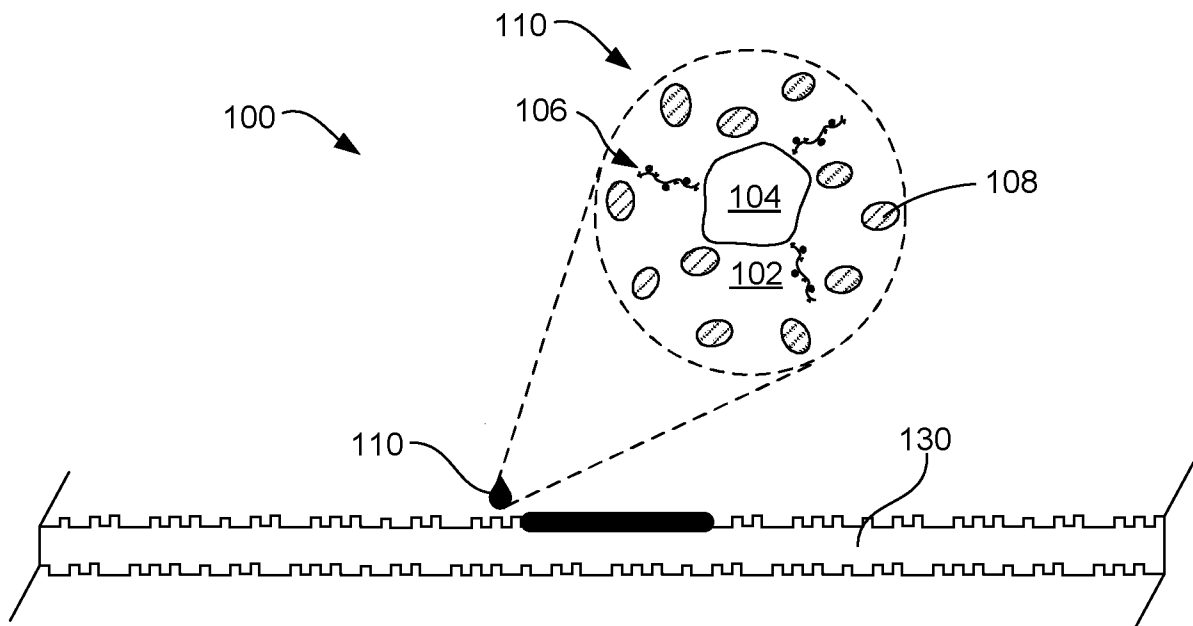


FIG. 1

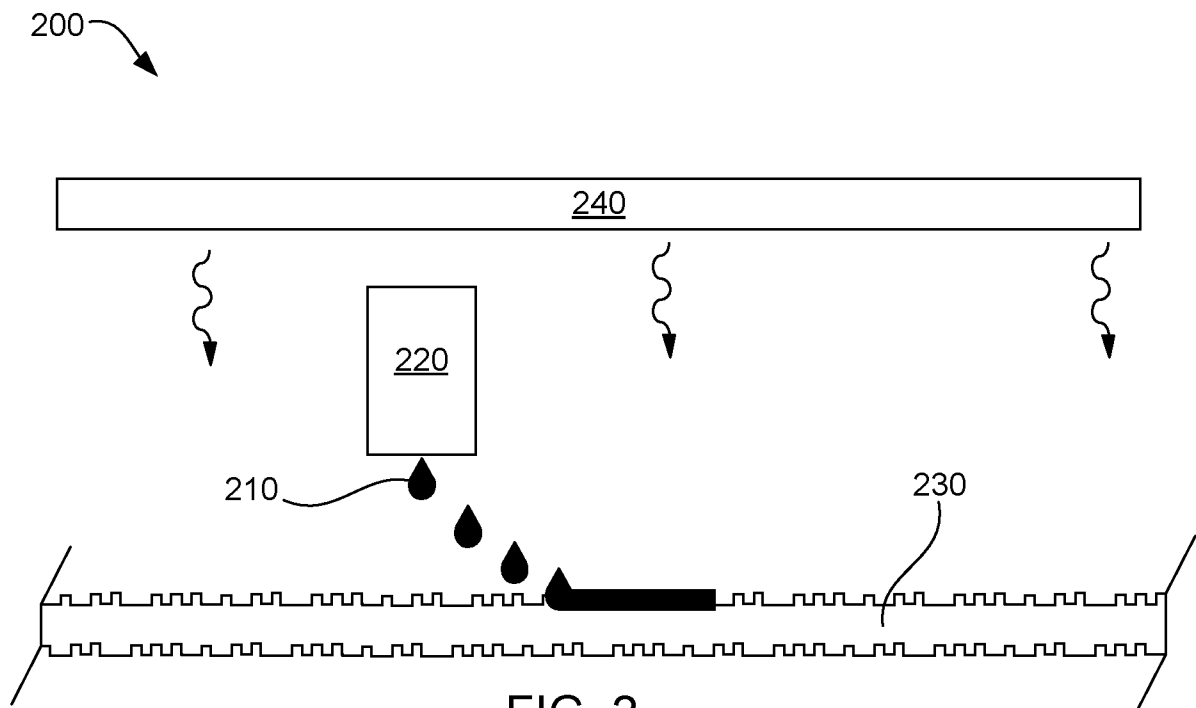


FIG. 2

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ejecting an ink composition onto a fabric substrate, wherein the ink composition comprises water, organic co-solvent, from 0.5 wt% to 10 wt% pigment, wherein the pigment has a dispersant associated with a surface thereof, and from 0.5 wt% to 20 wt% latex particles including styrene (meth)acrylic polymer having an acid number from 0 mg KOH/g to 60 mg KOH/g and a glass transition temperature from -30° C to 50° C, wherein the latex particles are uncrosslinked

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FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2018/060269

A. CLASSIFICATION OF SUBJECT MATTER		
D06P 1/92 (2006.01) D06P 5/04 (2006.01) D06P 5/30 (2006.01) 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) D06P 1/00, D06P 1/04, D06P 1/44, D06P 1/46, D06P 1/90, D06P 1/92, D06P 5/04, D06P 5/24, D06P 5/26, D06P 5/30		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011/0303113 A1 (GEORGE SARKISIAN et al) 15.12.2011, abstract, [0004]-[0058]	1-15
Y	US 2004/0001926 A1 (EASTMAN KODAK COMPANY) 01.01.2004, abstract, [0009]-[0123]	1-15
Y	WO 2016/175870 A1 (HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.) 03.11.2016, abstract	2
Y	US 2012/0236069 A1 (SEIKO EPSON CORPORATION) 20.09.2012, [0008]-[0009]	9
A	US 2013/0044157 A1 (HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.) 21.02.2013	1-15
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier document but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family		
Date of the actual completion of the international search 09 July 2019 (09.07.2019)		Date of mailing of the international search report 11 July 2019 (11.07.2019)
Name and mailing address of the ISA/RU: Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37		Authorized officer I. Doroshenko Telephone No. 8 499 240 25 91