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(54) **Ink jet recording element and printing method**

Tintenstrahl-Aufzeichnungselement und Aufzeichnungsverfahren

Elément pour l'impression au jet d'encre et procédé d'impression

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Description

[0001] The present invention relates to a porous ink jet recording element and a printing method using the element.

[0002] In a typical ink jet recording or printing system, ink droplets are ejected from a nozzle at high speed towards a recording element or medium to produce an image on the medium. The ink droplets, or recording liquid, generally comprise a recording agent, such as a dye or pigment, and a large amount of solvent. The solvent, or carrier liquid, typically is made up of water, an organic material such as a monohydric alcohol, a polyhydric alcohol or mixtures thereof.

[0003] An inkjet recording element typically comprises a support having on at least one surface thereof at least one ink-receiving layer. The ink-receiving layer is typically either a porous layer that imbibes the ink via capillary action, or a polymer layer that swells to absorb the ink. Swellable hydrophilic polymer layers take an undesirably long time to dry. Porous ink-receiving layers are usually composed of inorganic or organic particles bonded together by a binder. The amount of particles in this type of coating is often far above the critical particle volume concentration, which results in high porosity in the coating. During the inkjet printing process, ink droplets are rapidly absorbed into the coating through capillary action and the image is dry-to-touch right after it comes out of the printer. Therefore, porous coatings allow a fast "drying" of the ink and produces a smear-resistant image.

[0004] Ink jet prints, prepared by printing onto ink jet recording elements, are subject to environmental degradation. They are especially vulnerable to damage resulting from contact with water and atmospheric gases such as ozone. The damage resulting from the post imaging contact with water can take the form of water spots resulting from deglossing of the top coat, dye smearing due to unwanted dye diffusion, and even gross dissolution of the image recording layer. Ozone bleaches ink jet dyes resulting in loss of density. To overcome these deficiencies, ink jet prints are often laminated. However, lamination is expensive as it requires a separate roll of material.

[0005] U.S. Patents 4,785,313 and 4,832,984 relate to an ink jet recording element comprising a support having thereon a fusible, ink-transporting layer and an ink-retaining layer, wherein the ink-retaining layer is non-porous. However, there is a problem with this element in that it has poor image quality.

[0006] EP 858, 905A1 relates to an ink jet recording element having a porous, outermost layer formed by heat sintering thermoplastic particles such as polyurethane which may contain a slight amount of a hydrophilic binder such as poly(vinyl alcohol). However, there is a problem with this element in that it has poor resistance to mechanical abrasion when it does not contain a hydrophilic binder, and poor water-resistance when it does contain a hydrophilic binder.

[0007] It is an object of this invention to provide an inkjet recording element having a fusible protective uppermost layer and ink-retaining underlayer which can be printed with ink jet inks without bleed. It is another object of the invention to provide a porous ink-transporting layer that has good mechanical integrity and is abrasion resistant. It is another object of the invention to provide a protective uppermost ink-transporting layer that is thermally fusible and thereby can be rendered water resistant. It is another object to provide an inkjet recording element that can be thermally fused to provide high density of the printed image.

[0008] Another object of the invention is to provide a printing method using the above-described element.

[0009] These and other objects are achieved in accordance with the invention which comprises an ink jet recording element comprising a support having thereon in order:

a) at least one porous, ink-retaining layer; and
b) a fusible, porous ink-transporting layer comprising fusible, polymeric particles and a film-forming, hydrophobic binder.

[0010] By use of the invention, a porous inkjet recording element is obtained that has good abrasion resistance, and which when printed with an ink jet ink, and subsequently fused, has good water-resistance and high print density.

[0011] Another embodiment of the invention relates to an ink jet printing method comprising the steps of:

I) providing an ink jet printer that is responsive to digital data signals;
II) loading the printer with the ink jet recording element described above;
III) loading the printer with an ink jet ink composition;
IV) printing on the image-receiving layer using the ink jet ink composition in response to the digital data signals; and
V) fusing the fusible, porous ink-transporting layer to provide a continuous polymeric layer on the surface of the inkjet recording element.

[0012] The fusible, polymeric particles employed in the invention may have any particle size provided they will form a porous layer. In a preferred embodiment of the invention, the particle size of the fusible, polymeric particles may range from 0.5 to 10 μm. The particle may be formed from any polymer which is fusible, i.e., capable of being converted from discrete particles into a continuous layer through the application of heat and/or pressure. In a preferred embodiment of the invention, the fusible, polymeric particle comprises a condensation polymer, a styrenic polymer, a vinyl polymer, an

ethylene-vinyl chloride copolymer, a polyacrylate, poly(vinyl acetate), poly(vinylidene chloride), a vinyl acetate-vinyl chloride copolymer. In still another preferred embodiment, the condensation polymer may be a polyester or polyurethane.

[0013] The film-forming, hydrophobic binder useful in the invention can be any film-forming hydrophobic polymer capable of being dispersed in water. In a preferred embodiment of the invention, the hydrophobic binder is an aqueous dispersion of an acrylic polymer or a polyurethane.

[0014] The particle-to-binder ratio of the particles and binder employed in the ink-transporting layer can range between 98:2 and 60:40, preferably between 95:5 and 80:20. In general, a layer having particle-to-binder ratios above the range stated will usually not have sufficient cohesive strength; and a layer having particle-to-binder ratios below the range stated will usually not be sufficiently porous to provide good image quality.

[0015] In a preferred embodiment of the invention, the ratio of the mean volume weighted size of the dispersed film forming hydrophobic polymeric binder particles to the fusible, polymeric particles is preferably 0.15 to 1, and more preferably greater than 0.41 to 1, as determined by a Horiba LA-920 Laser Scattering Particle Size Distribution Analyzer (Horiba Instruments, Inc.). While not being bound by any theory, it is believed that if the ratio is below the lower limit stated, the binder particles pass through the interparticle voids between the larger fusible particles, and deposit at the interface with the ink-retaining layer. The resultant structure blocks ink flow into the ink-retaining layer, resulting in undesirable bleed. The interparticle voids are taken to be the radius in the plane of contact of the interstice, r, formed by three spheres of radius, R. In a close packed array, r = 0.15R, and in the more open array of square packed spheres r = 0.41R.

[0016] The ink-retaining layer can be any porous structure, but it is preferred that the mean pore radius is smaller than the uppermost ink-transporting layer. Thus, if the ink-retaining layer is composed of particles and binder, the particles will be significantly smaller than the fusible, polymeric particles in the upper ink-transporting layer, thereby assuring a correct pore-size hierarchy.

[0017] In general, the ink-retaining layer or layers will have a thickness of 1 μm to 50 μm, and the top ink-transporting layer will usually have a thickness of 2 μm to 50 μm. In a preferred embodiment, the ink-retaining layer is present in an amount from 1 g/m^2 to 50 g/m^2, preferably from 5.0 g/m^2 to 30 g/m^2.

[0018] In a preferred embodiment of the invention, the ink-retaining layer is a continuous, co-extensive porous layer which contains organic or inorganic particles. Examples of organic particles which may be used include core/shell particles such as those disclosed in U.S.S.N. 09/609,969 of Kapusniak et al., filed June 30, 2000, and homogeneous particles such as those disclosed in U.S.S.N. 09/608,466 of Kapusniak et al., filed June 30, 2000. Examples of organic particles which may be used include acrylic resins, styrenic resins, cellulose derivatives, polyvinyl resins, ethylene-allyl copolymers and polycondensation polymers such as polyesters. Examples of inorganic particles which may be used in the ink-retaining layer of the invention include silica, alumina, titanium dioxide, clay, calcium carbonate, barium sulfate, or zinc oxide.

[0019] In a preferred embodiment of the invention, the porous ink-retaining layer comprises from 20 % to 100 % of particles and from 0 % to 80 % of a polymeric binder, preferably from 80% to 95 % of particles and from 20 % to 5 % of a polymeric binder. The polymeric binder may be a hydrophilic polymer such as poly(vinyl alcohol), poly(vinyl pyrrolidone), gelatin, cellulose ethers, poly(oxazolines), poly(vinylacetamides), partially hydrolyzed poly(vinyl acetate/vinyl alcohol), poly(acrylic acid), poly(acrylamide), poly(alkylene oxide), sulfonated or phosphated polyesters and polystyrenes, casein, zein, albumin, chitin, chitosan, dextran, pectin, collagen derivatives, collodian, agar-agar, arrowroot, guar, carrageenan, tragacanth, xanthan, rhamsan and the like. Preferably, the hydrophilic polymer is poly(vinyl alcohol), hydroxypropyl cellulose, hydroxypropyl methyl cellulose, a poly(alkylene oxide), poly(vinyl pyrrolidinone), poly(vinyl acetate) or copolymers thereof or gelatin.

[0020] Suitable porous materials for an ink-retaining layer include, for example, silica or alumina in a polymeric binder. In a preferred embodiment, the ink-retaining layer is porous fumed alumina in a crosslinked poly(vinyl alcohol) binder.

[0021] In order to impart mechanical durability to an ink jet recording element, crosslinkers which act upon the binder discussed above may be added in small quantities. Such an additive improves the cohesive strength of the layer. Crosslinkers such as carbodiimides, polyfunctional aziridines, aldehydes, isocyanates, epoxides, polyvalent metal cations, vinyl sulfones, pyridinium, pyridylium dication ether, methoxylkyl melamines, triazines, dioxane derivatives, chrom alum, zirconium sulfate and the like may be used. Preferably, the crosslinker is an aldehyde, an acetal or a ketal, such as 2,3-dihydroxy-1,4-dioxane.

[0022] The porous ink-retaining layer can also comprise an open-pore polyolefin, an open-pore polyester or an open pore membrane. An open pore membrane can be formed in accordance with the known technique of phase inversion. Examples of a porous ink-receiving layer comprising an open-pore membrane are disclosed in U.S.S.N. 09/626,752 and U.S.S.N. 09/626,883, both of Landry-Coltrain et al., filed July 27, 2000.

[0023] In another preferred embodiment of the invention, two porous, ink-retaining layers are present. In this embodiment, the uppermost layer is substantially the same as the lower layer, but at a thickness of only 1 % to 20 % of the thickness of the lower layer, and also contains from 1-20 % by weight of a mordant, such as a cationic latex mordant.

[0024] The two porous, ink-retaining layers can be coated simultaneously or sequentially by any of the known coating

techniques as noted below. The dye image is then concentrated at the thin uppermost ink-retaining layer containing a mordant, and thereby enhances print density.

[0025] The support used in the ink jet recording element of the invention may be opaque, translucent, or transparent. There may be used, for example, plain papers, resin-coated papers, various plastics including a polyester resin such as poly(ethylene terephthalate), poly(ethylene naphthalate) and poly(ester diacetate), a polycarbonate resin, a fluorine resin such as poly(tetra-fluoro ethylene), metal foil, vinyl, fabric, laminated or coextruded supports, various glass materials, and the like. In a preferred embodiment, the support is a resin-coated paper. The thickness of the support employed in the invention can be from 12 to 500 μm, preferably from 75 to 300 μm.

[0026] If desired, in order to improve the adhesion of the base layer to the support, the surface of the support may be corona-discharge-treated prior to applying the base layer or solvent-absorbing layer to the support.

[0027] Since the image recording element may come in contact with other image recording articles or the drive or transport mechanisms of image recording devices, additives such as surfactants, lubricants, UV-absorbing agents, matte particles and the like may be added to the element to the extent that they do not degrade the properties of interest.

[0028] The layers described above, including the base layer and the top layer, may be coated by conventional coating means onto a support material commonly used in this art. Coating methods may include, but are not limited to, wound wire rod coating, slot coating, slide hopper coating, gravure, curtain coating and the like. Some of these methods allow for simultaneous coatings of both layers, which is preferred from a manufacturing economic perspective.

[0029] After printing on the element of the invention, the fusible, porous ink-transporting layer is heat and/or pressure fused to form an overcoat layer on the surface. Fusing is preferably accomplished by contacting the surface of the element with a heat fusing member, such as a fusing roller or fusing belt. Thus, for example, fusing can be accomplished by passing the element through a pair of heated rollers, heated to a temperature of 60 °C to 160 °C, using a pressure of 5 to 15 MPa at a transport rate of 0.005 m/s /to 0.5 m/s.

[0030] Ink jet inks used to image the recording elements of the present invention are well-known in the art. The ink compositions used in ink jet printing typically are liquid compositions comprising a solvent or carrier liquid, dyes or pigments, humectants, organic solvents, detergents, thickeners, preservatives, and the like. The solvent or carrier liquid can be solely water or can be water mixed with other water-miscible solvents such as polyhydric alcohols. Inks in which organic materials such as polyhydric alcohols are the predominant carrier or solvent liquid may also be used. Particularly useful are mixed solvents of water and polyhydric alcohols. The dyes used in such compositions are typically water-soluble direct or acid type dyes. Such liquid compositions have been described extensively in the prior art including, for example, U.S. Patents 4,381,946; 4,239,543 and 4,781,758.

[0031] The following examples further illustrate the invention.

Example 1

Synthesis of Polyurethane Polymer

[0032] In a 2 liter resin flask equipped with thermometer, stirrer, water condenser and vacuum outlet, 123 g (0.041 mole) Polyester polyol, Tone® 0260, (Union Carbide Corp.), Mw 3000, was melted and dewatered under vacuum at 90°C. The vacuum was released and at 40°C there was then added 10.20 g (0.076 mole) 2,2- Bis(hydroxymethyl)propionic acid, 128.76 g (0.383 mole) Hexafluorobisphenol A, 75 g of Reagent grade Ethyl Acetate, and 20 drops of Dibutyltin Dilaurate (catalyst). The temperature was adjusted to 80°C and the contents stirred for 30 minutes. The temperature was lowered to 70°C and while stirring, 111.20 g (0.50 mole) of isophrone diisocyanate and 10 g ethyl acetate were added. The temperature was raised to 80°C and reaction stirred at temperature until completion which gave, upon cooling, a 60.6 weight percent solids solution. The solution was used to prepare the polyurethane particles P1 described below.

Preparation of Polyurethane Particles - P1

[0033] To 194.8 g of the above 60.6 % weight percent solids polyurethane dissolved in ethyl acetate described above was added 172.0 g of ethyl acetate and 4.0 g of triethanolamine. A separate aqueous composition was prepared by mixing 26.8 g of ethyl acetate and 1202.4 g of deionized water. The organic composition was added slowly to the aqueous composition using a low shear propeller mixing device. The resulting oil-in-water emulsion was then subjected to a high shear Brinkman rotor-stator mixer for 5 minutes at 5000 rpm. The ethyl acetate was removed by rotary evaporation under vacuum at 68°C and the particles were concentrated to afford a 30 % solids dispersion of 2 μm particles.

Preparation of Polystyrene Particles - P2

[0034] To 333 g styrene was added 10 g 2,2'- azobis(2,4-dimethylvaleronitrile), Vazo 52® (DuPont Corp.), and stirred

until the Vazo 52® dissolved. Separately, an aqueous phase was prepared by adding to 1000 g of distilled water, 10.43 g potassium hydrogen phthalate, 4 g 0.1N HCl, 7.2 g poly(adipic acid-co-methylaminoethanol) and 91.5 g of Ludox TM® colloidal silica, and stirring for 15 minutes. The organic phase was then added to the stirred (marine prop agitator) aqueous phase and stirred for 15 minutes. The resultant dispersion was passed through a Gaulin homogenizer twice at 20.7 MPa and then heated at 54°C for sixteen hours. There was thereby obtained a narrowly distributed population of 2 μm polystyrene particles.

Preparation of Coating Solutions for Ink-transporting Upper Layer

[0035] Coating solution S1 was prepared by adding to the P1 particles the hydrophobic binder, B1, Witcobond ®W320, an aqueous dispersion of 1.9 polyurethane particles Tg = -12°C. The coating solution at 20 % solids comprised 90 parts by weight P1 particle solids and 10 parts by weight binder solids.

[0036] Coating solution S2 was prepared by adding to the P2 particles the same hydrophobic binder. The solution at 20 % solids comprised 85 parts P2 particle solids and 15 parts binder solids.

Preparation of Porous Ink-Retaining Lower Layers

[0037] A polyethylene resin-coated paper support was corona discharge treated. The support was then hopper coated and force air dried at 60°C to provide the following ink-retaining layers:

Layer L1- a 38 μm layer comprising 87 % fumed alumina, 9 % poly(vinyl alcohol), and 4 % dihydroxydioxane crosslinking agent

Layer L2- a two layer structure comprising L1 and coated simultaneously on L1 a 2 μm layer comprising 87 % fumed alumina, 8 % 100nm colloidal latex dispersion of divinylbenzene-co-N- vinylbenzyl- N,N,N - trimethylammonium chloride, 6 % poly(vinyl alcohol), and 1 % Zonyl ®FSN surfactant (Dupont Corp.).

Preparation of Control Non-Porous Hydrophilic Ink-Retaining Layers

[0038] Hydrophilic Layer L3 - an aqueous solution comprising 6.7 % gelatin, and 1.2 % poly(vinyl pyrrolidone), K90 (International Specialty Products Co.) was hopper coated to provide an ink-retaining layer of 8.6 g/m^2.

[0039] The following control layers were rod coated:

Hydrophilic Layer L_4- an aqueous solution comprising 10% poly(vinyl pyrrolidone), K90 (International Specialty Products Co.) was rod coated and air dried to provide a base layer of 8.0 g/m^2;

Hydrophilic Layer L5- a layer comprising polyvinyl alcohol at 8.0 g/m^2 was prepared in like fashion.

Element 1 of the Invention

[0040] The porous ink-transporting layer was prepared by separately coating solutions as shown in Table 1 over the porous ink-retaining layers as shown in Table 1 using a wire wound rod, calibrated to give a wet laydown of 40 μm and air dried.

Control Elements C-1 through C-4

[0041] These elements were prepared the same as Element 1 except using the solutions and ink-retaining layers as shown in Table 1.

Control Elements C-5 through C-8

[0042] These elements were layers L2 through L5 without the ink-transporting layer.

Printing

[0043] A bleed test target was printed on the elements and controls with a Hewlett-Packard Photosmart® printer. The target design had seven adjacent 9 mm by 48 mm rectangular bars, each bar was one of the primary or secondary subtractive color i.e. C,M,Y,R,G,B,K, and in each bar was embedded six 7 mm squares of the other colors. So, for example, the Cyan bar had embedded squares of M,Y,R,G,B,K.

Testing

[0044] The printed elements were then examined for bleed with the following evaluation standards:

5: No change in the shape of the embedded squares with sharp edges of the squares maintained
3: The square pattern was slightly rounded with smooth edges
1: Major spreading and deformation of the rectangular pattern with ragged edges.

[0045] An evaluation of 5 or 3 is necessary for good image quality. The following results were obtained:

Table 1

Element	Solution	Ink-Retaining Layer	Bleed
1	S1	L1	5
2	S1	L2	5
3	S2	L2	5
Control 1	S1	L3	1
Control 2	S1	L4	1
Control 3	S1	L5	1
Control 4	S2	L3	1
Control 5	-	L2	5
Control 6	-	L3	5
Control 7	-	L4	5
Control 8	-	L5	5

[0046] The above results show that the elements of the invention having a fusible, porous ink-transporting uppermost layer and porous ink-retaining bottom layers have excellent bleed performance, whereas the control elements having the same ink-transporting layer over a non-porous hydrophilic ink-retaining layer have poor bleed performance which is significantly worse than that of the hydrophilic layer alone.

Example 2

Preparation of Urethane Particles employed in the Invention

Particle P3

[0047] In a 2 liter resin flask equipped with thermometer, stirrer, water condenser and a vacuum outlet, 107.5 g (0.125 mole) polycarbonate polyol PC 1733, Mw = 860, (Stahl Co.) was melted and dewatered under vacuum at 100°C. The vacuum was released and then at 40°C, 10.2 g (0.076 mole) dimethylol propionic acid, 100.52 g (0.299 mole) bisphenol AF, and 75 g methyl ethyl ketone were added. Then 20 drops dibutyltin dilaurate (catalyst) was added while stirring. The temperature was adjusted to 75°C and maintained until a homogeneous reaction mixture was obtained. Slowly, 111.2 g (0.50 mole) isophorone diisocyanate was added followed by 10 g methyl ethyl ketone. The temperature was raised to 85°C and maintained until the isocyanate functionality was reduced to substantially nil. While stirring, a stoichiometric amount of potassium hydroxide based on dimethylol propionic acid was added, and maintained for 5 minutes. An amount of water 5 times the amount of methyl ethyl ketone was added with rapid stirring to form a milky white aqueous dispersion. The mean particle size was 6.1 μm as determined using a Horiba LA-920 Particle Size Analyzer.

Binders

[0048] The following binders were employed in this Example for Elements of the Invention:

Hydrophobic Binder B1 Witcobond® W320 an aqueous dispersion of 1.9 micron polyurethane particles Tg = -12°C from Uniroyal Chemical Co.

Hydrophobic Binder B2 Witcobond® W507 an aqueous dispersion of 1.9 micron polyurethane particles Tg = -30°C from Uniroyal Chemical Co.
Hydrophobic Binder B3 Witcobond® W290H an aqueous dispersion of 1.9 micron polyurethane particles Tg = -44°C from Uniroyal Chemical Co.

[0049] The following binders were employed in this Example for Control Elements:

Hydrophilic Binder B4 - Methyl Cellulose A4M a water-soluble polymer from Dow Chemical Co.
Hydrophilic Binder B5- A water soluble polyvinyl alcohol from Nippon Gohsei Co.
Hydrophilic Binder B6- Limed ossein gelatin.

Elements 4-7 of the Invention

[0050] The porous ink-transporting layer was prepared by coating an 8.1 % solids dispersion comprised of 85 parts particles P3 and 15 parts hydrophobic binder B1. The dispersion was coated with a 40 μm wire wound rod over the porous ink-retaining layer L2 described in Example 1 to form Element 4. Elements 5-7 were similarly prepared from 20 % solids dispersions comprised of 90 parts particles P1 and 10 parts hydrophobic binder in the combinations given in the table below.

Control Elements C9 - C11

[0051] These elements were prepared by coating a 10 % solids dispersion comprised of 95 parts particles P3 and 10 parts hydrophilic binder B4 on the porous ink-retaining layer L2. Controls 10 and 11 were similarly prepared and coated from 20 % solids dispersions comprised of 90 parts particles P1 and 10 parts hydrophilic binders in the combinations given in the table below.

Printing

[0052] A test target comprised was printed with a Hewlett-Packard Photosmart® printer. The target consisted of seven sets of four 1 cm^2 color patches, a set in each of the primary and secondary colors and black. Each patch was printed at a single density, the set ranging from 25 % to 100 % density in equal steps.

Fusing and Testing

[0053] The printed elements and controls were fused in a heated nip at 150°C and 4.2 kg/cm^2 against a sol-gel coated polyimide belt at 63.5 cm/min. A water drop was placed on each color patch of the fused print for 30 minutes and then blotted. Waterfastness was judged by the transfer of dye to the blotter and density loss in the blotted color patch on the following scale:

5 - no dye transfer to blotter and no density loss observable in the color patch.
1- heavy dye transfer to blotter and significant density loss in blotted color patch.

Table 2

Element	Particles	Binder	Water Resistance
4	P3	B 1	5
5	P1	B1	5
6	P1	B2	5
7	P1	B3	5
Control 9	P3	B4	1
Control 10	P1	B5	1
Control 11	P1	B6	1

[0054] The above results show that the elements 4-7 of the invention with a hydrophobic binder in the porous ink-trans-

porter layer had excellent water resistance whereas the controls with a hydrophilic binder in the ink-transporting layer have poor water resistance.

Example 3

[0055] The following particles were used in this Example:

Particles P4 -prepared substantially as per P3 but neutralized with a stoichiometric amount of triethanol amine and dispersed using Aerosol®OT surfactant affording a particle size 3.8 microns.
Particles P5 - prepared substantially as per P1 but with a particle size of 2.4 microns.
Particles P6 - prepared substantially as per P3 but neutralized with one half the stoichiometric amount of KOH affording a particle size of 30 microns.

[0056] In addition to Binder B1, B2 and B3 described above, the following additional binders were used in this Example:

Binder B7- Epocros® 2010 a commercially available acrylic latex obtained from Esprix Technologies mean particle size 0.15 μm
Binder B8- Epocros® 2020 a commercially available acrylic latex obtained from Esprix Technologies mean particle size 0.10 μm
Binder B9- Witcobond® 234 an aqueous dispersion of 0.10 micron polyurethane particles Tg =-28°C.

Elements 8 - 13 of the Invention

[0057] Aqueous 20 % solids dispersions were prepared from combinations of the above particles and binders at 90 parts polyurethane particles and 10 parts binder particles in combinations whose binder to particle size ratio was at least 0.15 and coated with a 40 μm wire wound rod over the porous ink-retaining layer L2 from Example 1 to form elements of the invention 8 -13, as shown in Table 3.

Controls C12 - C18

[0058] Controls C12 - C18 were prepared similar to Elements 8-13 except combinations of particles and binder were chosen whose size ratio was less than 0.15. Control 1 had no binder and Control 18 was Canon "HyperPhoto" media, a commercially available product with a sintered ink-transporting layer, as shown in Table 3.

Testing

[0059] Abrasion resistance of the unfused coatings was tested by contacting the coatings with a 2.5 by 8.0 cm strip of acid free 29.5 kg card stock black paper from Fiskars Inc., and applying a 4.4 N force to the latter third of the strip while uniformly transporting it across the coating. The test was evaluated by noting the density of white powder transferred to the black paper strip according to the following criteria:

5- No transfer
3- Light transfer
1- Heavy transfer

[0060] A rating less than 3 is unacceptable for abrasion resistance. A bleed test target was printed and the elements and controls were then fused as described in Example 2. The bleed target was evaluated as described in Example 1.

Table 3

Element	Binder Size (μm)	Particle Size (μm)	B/P Size Ratio	Bleed	Abrasion
8	B1 (1.9)	P1 (3.8)	0.5	5	5
9	B2 (1.0)	P1 (3.8)	0.26	3	5
10	B3 (1.1)	P1 (3.8)	0.29	3	5
11	B1(1.9)	P2 (2.4)	0.79	5	5
12	B2 (1.0)	P2 (2.4)	0.41	5	5

Table continued

Element	Binder Size (μm)	Particle Size (μm)	B/P Size Ratio	Bleed	Abrasion
13	B3 (1.1)	P2 (2.4)	0.49	5	5
Control 12	-	P1 (3.8)	0.0	5	1
Control 13	B7 (0.15)	P 1 (3.8)	0.04	1	-
Control 14	B8 (0.10)	P1 (3.8)	0.03	1	-
Control 15	B9 (0.10)	P1 (3.8)	0.03	1	-
Control 16	B9 (0.10)	P2 (2.4)	0.04	1	-
Control 17	B1 (1.9)	P6 (30)	0.06	1	-
Control 18	-	(0.5)	0.0	5	3

[0061] The above results show that Elements 8-13 of the invention exhibited little or no bleed with good mechanical integrity whereas the control elements were deficient in abrasion resistance.

Example 4

Particles

[0062] Urethane particles P1 from Example 1 were used.

Binders

[0063] Hydrophobic binders B1 - B3 from Example 2 were used.

Ink-Retaining Layers

[0064] The ink-retaining layers L1 and L2 from Example 1 were used.

Elements 14-16 of the Invention

[0065] The ink-transporting layer was prepared by coating dispersions formed from combining urethane particles P1 at 90 parts by weight with each of the binders B1-B3 at 10 parts by weight to give 20 % solids dispersions. The dispersions formed with binders B1-B3 were coated with a 40 μm wire-wound rod on porous ink-retaining layer L-2.

Controls 19-21

[0066] The controls were prepared similar to Elements 14-16 except that the dispersions formed by combining the particles with binders B1-B3 were coated on the porous ink-retaining layer L1.

Printing

[0067] A test target comprised was printed with a Hewlett-Packard Photosmart® printer. The target consisted of 3cm^2 color patches at 100 % density in each of the primary and secondary colors and black.

Fusing and Testing

[0068] The printed elements and controls were fused as in Example 2. The densities of the printed patches were then read with the following results.

Table 4

Element	Blue	Cyan	Magenta	Yellow	Green	Red	Black
14	2.08	2.05	1.86	1.79	1.21	0.72	2.0

Table continued

Element	Blue	Cyan	Magenta	Yellow	Green	Red	Black
15	2.1	1.75	1.9	1.77	1.23	0.72	2.06
16	2.00	1.98	1.83	1.72	1.22	0.71	1.99
Control 19	1.85	2.07	1.68	1.65	1.22	0.73	1.88
Control 20	1.84	2.04	1.69	1.65	1.19	0.72	1.88
Control 21	1.84	1.96	1.68	1.64	1.19	0.72	1.88

[0069] The above results show that Elements 14-16 of the invention with two porous ink-retaining layers and whose thin upper layer contains a mordant having significantly higher magenta, yellow, blue and black densities than the control elements.

Claims

1. An ink jet recording element comprising a support having thereon in order:

a) at least one porous, ink-retaining layer; and
b) a fusible, porous ink-transporting layer comprising fusible, polymeric particles and a film-forming, hydrophobic binder.

2. The element of Claim 1 wherein said ink-transporting layer is prepared by coating on said ink-retaining layer an aqueous dispersion of said fusible, polymeric particles and particles of said film-forming, hydrophobic binder, followed by drying.

3. The element of Claim 2 wherein the size ratio of the hydrophobic binder particles to said fusible, polymeric particles is at least 0.15 and the mean pore radius of said ink-transporting layer being greater than that of the ink-retaining layer.

4. The element of Claim 1 wherein the particle size of said fusible, polymeric particles is from 0.5 to 10 μm.

5. The ink jet recording element of Claim 1 wherein the particle-to-binder ratio of the ink-transporting layer is between 95:5 and 60:40.

6. The element of Claim 1 wherein said porous, ink-retaining layer comprises from 20 % to 100 % of particles and from 0 % to 80 % of a polymeric binder.

7. The element of Claim 1 wherein said porous ink-retaining layer comprises from 50 % to 95 % of particles and from 50 % to 5 % of a polymeric binder.

8. The element of Claim 6 wherein said particles comprise silica, alumina, titanium dioxide, clay, calcium carbonate, barium sulfate or zinc oxide.

9. The element of Claim 6 wherein said polymeric binder is poly(vinyl alcohol), hydroxypropyl cellulose, hydroxypropyl methyl cellulose, a poly(alkylene oxide), poly(vinyl pyrrolidinone), poly(vinyl acetate) or copolymers thereof, or gelatin.

10. An ink jet printing method comprising the steps of:

I) providing an ink jet printer that is responsive to digital data signals;
II) loading said printer with the ink jet recording element of Claim 1;
III) loading said printer with an ink jet ink composition;
IV) printing on said image-receiving layer using said ink jet ink composition in response to said digital data signals; and
V) fusing said fusible, porous ink-transporting layer to provide a continuous polymeric layer on the surface of said ink jet recording element.

Patentansprüche

1. Tintenstrahlaufzeichnungselement mit einem Träger, auf dem in folgender Reihenfolge folgende Schichten angeordnet sind:

   a) mindestens eine poröse Tintenaufnahmeschicht; und
   b) eine fixierbare, poröse Tintentransportschicht mit fixierbaren, polymeren Partikeln und einem filmbildenden, hydrophoben Bindemittel.

2. Tintenstrahlaufzeichnungselement nach Anspruch 1, worin die Tintentransportschicht hergestellt wird durch Auftragen einer wässrigen Dispersion der fixierbaren, polymeren Partikel und der Partikel des filmbildenden, hydrophoben Bindemittels auf der Tintenaufnahmeschicht und anschließendes Trocknen.

3. Tintenstrahlaufzeichnungselement nach Anspruch 2, worin das Größenverhältnis der Partikel des hydrophoben Bindemittels zu den fixierbaren, polymeren Partikeln mindestens 0,15 beträgt, und worin der mittlere Porenradius der Tintentransportschicht größer als der der Tintenaufnahmeschicht ist.

4. Tintenstrahlaufzeichnungselement nach Anspruch 1, worin die Partikelgröße der fixierbaren, polymeren Partikel zwischen 0,5 und 10 μm beträgt.

5. Tintenstrahlaufzeichnungselement nach Anspruch 1, worin das Verhältnis von Partikeln zu Bindemittel der Tintentransportschicht zwischen 95:5 und 60:40 beträgt.

6. Tintenstrahlaufzeichnungselement nach Anspruch 1, worin die poröse Tintenaufnahmeschicht zwischen 20% und 100% Partikel und zwischen 0% und 80% eines polymeren Bindemittels enthält.

7. Tintenstrahlaufzeichnungselement nach Anspruch 1, worin die poröse Tintenaufnahmeschicht zwischen 50% und 95% Partikel und zwischen 50% und 5% eines polymeren Bindemittels enthält.

8. Tintenstrahlaufzeichnungselement nach Anspruch 6, worin die Partikel Siliciumdioxid, Aluminiumoxid, Titandioxid, Ton, Calciumcarbonat, Bariumsulfat oder Zinkoxid umfassen.

9. Tintenstrahlaufzeichnungselement nach Anspruch 6, worin das polymere Bindemittel Poly(vinylalkohol), Hydroxypropylcellulose, Hydroxypropylmethylcellulose, Poly(alkylenoxid), Poly(vinylpyrrolidinon), Poly(vinylacetat) oder Copolymere davon oder Gelatine ist.

10. Tintenstrahldruckverfahren mit folgenden Schritten:

    I) Bereitstellen eines Tintenstrahldruckers, der auf digitale Datensignale anspricht;
    II) Beladen des Druckers mit dem Tintenstrahlaufzeichnungselement nach Anspruch 1;
    III) Beladen des Druckers mit einer Tintenstrahltintenzusammensetzung;
    IV) Bedrucken der Bildempfangsschicht mithilfe der Tintenstrahltintenzusammensetzung in Abhängigkeit von den digitalen Datensignalen; und
    V) Fixieren der fixierbaren, porösen Tintentransportschicht zur Bereitstellung einer durchgehenden polymeren Schicht auf der Oberfläche des Tintenstrahlaufzeichnungselements.

Revendications

1. Elément pour l'impression par jet d'encre comprenant un support revêtu dans l'ordre :

   a) d'au moins une couche poreuse de rétention d'encre ; et
   b) d'une couche poreuse fusible de transport d'encre comprenant des particules polymères fusibles et un liant filmogène hydrophobe.

2. Elément selon la revendication 1, dans lequel on prépare ladite couche de transport d'encre en appliquant sur ladite couche de rétention d'encre une dispersion aqueuse desdites particules polymères fusibles et des particules dudit liant filmogène hydrophobe, puis en la séchant.

3. Elément selon la revendication 2, dans lequel le rapport granulométrique des particules de liant hydrophobe auxdites particules polymères fusibles est d'au moins 0,15 et le rayon moyen des pores de ladite couche de transport d'encre est supérieur à celui de la couche de rétention d'encre.

4. Elément selon la revendication 1, dans lequel la taille de particule desdites particules polymères fusibles est comprise entre 0,5 et 10 μm.

5. Elément pour l'impression par jet d'encre selon la revendication 1, dans lequel le rapport des particules au liant de la couche de transport d'encre est compris entre 95:5 et 60:40.

6. Elément selon la revendication 1, dans lequel ladite couche poreuse de rétention d'encre comprend de 20% à 100% de particules et de 0% à 80% d'un liant polymère.

7. Elément selon la revendication 1, dans lequel ladite couche poreuse de rétention d'encre comprend de 50% à 95% de particules et de 50% à 5% d'un liant polymère.

8. Elément selon la revendication 6, dans lequel lesdites particules comprennent la silice, l'alumine, le dioxyde de titane, l'argile, le carbonate de calcium, le sulfate de baryum ou l'oxyde de zinc.

9. Elément selon la revendication 6, dans lequel ledit liant polymère est l'alcool polyvinylique, l'hydroxypropyl cellulose, l'hydroxypropyl méthyl cellulose, un polyoxyalkylène, la poly(vinyl pyrrolidinone), l'acétate polyvinylique ou des copolymères de ces derniers ou la gélatine.

10. Procédé d'impression par jet d'encre comprenant les étapes suivantes :

I) la fourniture d'une imprimante à jet d'encre sensible à des signaux de données numériques ;
II) le chargement dans ladite imprimante de l'élément pour l'impression par jet d'encre de la revendication 1 ;
III) le chargement dans ladite imprimante d'une composition d'encre pour jet d'encre ;
IV) l'impression sur ladite couche réceptrice d'image en utilisant ladite composition d'encre pour jet d'encre en réponse auxdits signaux de données numériques ; et
V) la fusion de ladite couche poreuse fusible de transport d'encre pour former un film polymère continu sur la surface dudit élément pour l'impression par jet d'encre.