

POLYMER BLENDS

FIELD OF THE INVENTION

The present invention relates to polymer blends which are useful in liquid toner compositions for imaging processes.

BACKGROUND OF THE INVENTION

Liquid toner compositions used in imaging processes generally comprise pigmented polymeric particles, a carrier liquid and charge director. Certain imaging processes use intermediate transfer members which receive an image from the photoconductor and transfer it to the final substrate, e.g. paper. When an intermediate transfer member (ITM) is used, the liquid toners should meet the following three criteria, namely, they should transfer well from the photoconductor to the ITM; they should transfer well from the ITM to the final substrate; and they must fuse well to the final substrate so that the image is abrasion resistant.

The transfer steps are preferably effected at as low a temperature as possible, because low temperature operations prolong the life of the ITM and the photoconductor. The liquid toners presently used in the art frequently contain Elvax^(R) II polymers or Surlyn^(R) polymers. While the Elvax II polymers generally transfer and fix well, some of them are too soft in the presence of carrier liquid to resist squashing during transfer to and from the intermediate transfer member. Those which do transfer and fix well require intermediate transfer member temperatures which marginally effect the operation of the photoreceptor and reduce the life of the intermediate transfer member.

In general Surlyn polymers wet paper substrates poorly and require very high temperatures for fixing on paper. These materials are, however, very hard and therefore are very abrasion resistant when they are fixed to paper at high temperatures.

SUMMARY OF THE INVENTION

In a liquid toner imaging system utilizing a photoreceptor and an intermediate transfer member (ITM),

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1 the toner image (which contains a substantial amount of
2 carrier liquid), at the start or transfer from the ITM to a
3 final substrate, e.g. paper, should have a relatively low
4 viscosity (optimally about 5×10^5 to 5×10^6 centipoises)
5 such that it flows into and wets the paper, yet on contact
6 with the paper (whereby the toner image cools somewhat),
7 the viscosity should substantially increase so that the
8 image transfers completely (i.e. not splitting between the
9 ITM and the substrate). Thus a semi-logarithmic cooling
10 curve of viscosity vs. temperature should show a transition
11 between a lower slope (slowly varying) portion for
12 temperatures above the knee and a high slope portion for
13 temperatures below the knee. The term "break-point" is used
14 herein in the specification and claims to describe this
15 transition. This knee should occur at or near the optimal
16 viscosity range at as low a temperature as possible and
17 should be as sharp as possible.

18 Moreover, the transferred image, while still
19 containing a high percentage of carrier liquid, should
20 preferably be hard, in order that an additional
21 fusing/fixing step in which solvent is evaporated, may be
22 avoided.

23 The known Elvax II (Dupont) polymers which are useful
24 as toner materials for example Elvax II 5650T and 5950,
25 when in a 40% NVS (non-volatile solids content) mixture
26 with Isopar L carrier liquid have a knee at approximately
27 the correct viscosity at a temperature of about 60°C. Other
28 Elvax II materials have a lower break-point temperatures
29 but their viscosity is low and they are more prone to
30 squash than the preferred Elvax II materials.

31 Surlyn polymers (Dupont) (which are "ionomers" derived
32 from ethylene/methacrylic acid copolymers), when used in
33 liquid toners, confer excellent abrasion resistance on the
34 image, but transfer poorly to paper and require very high
35 ITM temperature to effect fixing to substrates.

36 It is an object of one aspect of the present invention
37 to provide polymer blends which have broadly a similar
38 range of viscosity as the Elvax II 5650T and 5950 resins,



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1 but having a break point or turning point at a lower
2 temperature, whereby imaging processes, particularly those
3 employing an ITM, can be conducted at relatively low
4 temperatures. Other objects of the invention will appear
5 from the description which follows.

6 The present invention accordingly provides in one
7 aspect, a polymer blend of at least two distinct polymer
8 components, the blend being characterized by the fact that
9 in a 40% non-volatile mixture with a hydrocarbon liquid
10 toner carrier, on a semi-logarithmic viscosity vs.
11 temperature cooling curve, it has a break-point in the
12 viscosity vs. temperature curve at a temperature below
13 about 65°C and viscosity between about 3×10^5 and 5×10^6
14 centipoise.

15 Preferably at least one of the polymer components does
16 not have a break point in the preferred range.

17 In a preferred embodiment of the invention, one of the
18 polymers is an ionomer derived from ethylene/methacrylic
19 acid copolymer. One of the preferred polymers is a
20 terpolymer preferably an acid modified ethylene vinyl
21 acetate terpolymers. In a preferred embodiment of the
22 invention each of the components are present in the range
23 of between 25% and 75%.

24 In another aspect, the invention provides a liquid
25 toner for use in imaging processes which comprises
26 pigmented polymer particles, at least one charge director
27 and a hydrocarbon liquid toner carrier, wherein the polymer
28 comprised in the particles is a blend of at least two
29 distinct polymer components, the blend being characterized
30 by the facts recited in the preceding paragraphs.

31 The invention further provides, in an electrostatic
32 imaging process utilizing a liquid toner which includes
33 pigmented polymer particles, at least one charge director
34 and a hydrocarbon liquid toner carrier, the improvement
35 which comprises using as the polymer comprised in the
36 particles is a blend of at least two distinct polymer
37 components, the blend being characterized by the facts
38 recited in the preceding paragraphs.



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1 There is yet further provided by the present
2 invention, in an electrostatic imaging process utilizing a
3 liquid toner which includes pigmented polymer particles, at
4 least one charge director and a hydrocarbon liquid toner
5 carrier, and in which an image formed on the surface of a
6 photoconductor is developed by the toner, the image is
7 transferred from the surface to an intermediate transfer
8 member and from the intermediate transfer member to a
9 substrate, the improvement which comprises using as the
10 polymer comprised in the particles is a blend of at least
11 two distinct polymer components, the blend being
12 characterized by the facts recited in the preceding
13 paragraphs.

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BRIEF DESCRIPTION OF THE DRAWINGS

1 Fig. 1 shows the cooling curves of Elvax II polymers
2 at 40% NVS in Isopar L;
3 Fig. 2 shows the cooling curves of blends of Surlyn
4 9020 and Elvax 4260 polymers at 40% NVS in Isopar L;
5 Fig. 3 shows the cooling curves of blends of Surlyn
6 9020 and Elvax 4355 polymers at 40% NVS in Isopar L;
7 Fig. 4 shows the cooling curves of blends of Surlyn
8 1601 and Elvax 4355 polymers at 40% NVS in Isopar L;
9 Fig. 5 shows the cooling curves of blends of Surlyn
10 1601 and Elvax 4260 polymers at 40% NVS in Isopar L; and
11 Fig. 6 illustrates an electrostatic imaging apparatus
12 and process in which a liquid toner which includes the
13 polymer blend of the present invention may be employed.
14

DETAILED DESCRIPTION OF THE INVENTION

15 It has surprisingly been found in accordance with a
16 preferred embodiment of the present invention, that blends
17 of some Surlyn polymers with some Elvax (Dupont)
18 terpolymers, in certain proportions, possess the
19 viscosity/temperature characteristics of the invention,
20 which have been recited in the above summary (the
21 "criteria"). In particular instances, it has been found
22 that liquid toners containing pigmented polymer particles
23 wherein the polymer is constituted by such blends, may be
24 used in electrostatic imaging processes at either
25 comparable operating temperatures to those which are
26 utilized in the case of pigmented Elvax II polymer
27 particles, or even at advantageously lower temperature
28 ranges.
29

30 Fig. 1 shows (cooling) curves of viscosity vs.
31 temperature for various Elvax II resins in a 40% NVS (non-
32 volatile solids) mixture with Isopar L (EXXON), an
33 isopparaffinic hydrocarbon fraction, which is often used as
34 a carrier liquid in liquid developers. It is estimated that
35 40% NVS is the approximate proportion in a liquid toner
36 image when the image is transferred to paper.

37 As seen in Fig. 1 Elvax II 5650T and Elvax II 5950
38 resins have breakpoints within the desired range, where the

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1 breakpoint temperature is about 55°-65°C and the viscosity
2 is between 3×10^5 and 10^6 centipoise. While these break-
3 points are not especially sharp, these materials are
4 satisfactory toner polymers. Other Elvax II resins such as
5 Elvax II 5610 and Elvax II 5720 have viscosities which are
6 too low and in general are not preferred as toner particle
7 resins for liquid toners.

8 In practice the image cools by about 10°-15°C as it
9 comes in contact with a final substrate and the image does
10 not split on transfer from an intermediate transfer member
11 to the final substrate if it cools to a temperature above
12 the break point.

13 Fig. 2 shows (cooling) curves of viscosity vs.
14 temperature for various Surlyn 9020/Elvax 4260 blends. The
15 Surlyns are ionomers derived from ethylene/metacrylic acid
16 copolymers and the Elvaxs (as opposed to the Elvax IIs) are
17 acid modified ethylene vinyl acetate terpolymers. Both are
18 manufactured by Dupont corporation.

19 As seen in Fig. 2 both the pure Surlyn 9020 and the
20 pure Elvax 4260 do not meet the required optimum conditions
21 of break point temperature and viscosity. While Elvax 4260
22 does have a break-point at about 42°C, the viscosity at
23 this point is very low. Surlyn 9020 does not have a break-
24 point in the proper range and has a very high viscosity in
25 the desired temperature range. Neither of these resins has
26 been found to be a suitable polymer for low temperature
27 operation in an intermediate transfer imaging system.

28 Blends containing between 50% and 80% Surlyn 9020 do
29 meet the criteria and are believed to be suitable for use
30 in intermediate transfer liquid toner systems.

31 Fig. 3 shows (cooling) curves of viscosity vs.
32 temperature for various Surlyn 9020/Elvax 4355 blends. As
33 seen in Fig. 3 both the pure Elvax 4355 does not meet the
34 required optimum conditions of break point temperature and
35 viscosity. While Elvax 4260 does have a break-point at
36 about 35°C, the viscosity at this point is too low. This
37 resin has not been found to be suitable resin low
38 temperature operation in an intermediate transfer imaging



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1 system.

2 Blends containing 25%, 75% and 80% Surlyn 9020 do meet
3 the criteria and are believed to be suitable for use in
4 intermediate transfer liquid toner systems. The blend
5 containing 66% Surlyn 9020 marginally meets the criteria
6 and may also be suitable.

7 Fig. 4 shows (cooling) curves of viscosity vs.
8 temperature for various Surlyn 1601/Elvax 4355 blends. As
9 seen in Fig. 4 the pure Surlyn 1601 does not meet the
10 required optimum conditions of break point temperature and
11 viscosity. Surlyn 1601 does not have a break-point in the
12 proper range and has a very high viscosity in the desired
13 temperature range. This resin has not been found to be
14 suitable as a base for toner particles used for low
15 temperature operation in an intermediate transfer imaging
16 system.

17 Blends containing between 25% and 75% Surlyn 1601 do
18 meet the criteria and are believed to be suitable for use
19 in intermediate transfer liquid toner systems. The 80%
20 Surlyn blend marginally meets the criteria.

21 Fig. 5 shows (cooling) curves of viscosity vs.
22 temperature for various Surlyn 1601/Elvax 4260 blends.

23 Blends containing between 25% and 80% Surlyn 1601 do
24 appear to meet the criteria and are believed to be suitable
25 for use in intermediate transfer liquid toner systems.

26 While Figs. 2-5 do show a certain amount of
27 unpredictability regarding the suitability of a particular
28 blend even when the suitability of other blend of the same
29 materials is known. Notwithstanding this unpredictability,
30 the skilled person can of course readily determine the
31 viscosity/temperature relationships for any particular
32 polymer blend in order to know whether these are such that
33 the blend in question falls within the scope of the
34 invention.

35 It will further be appreciated that persons skilled in
36 the art may readily determine the optimal temperatures at
37 which the polymer blends of the invention, which in liquid
38 toners will of course be in an admixture with liquid toner



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1 carrier, pigment and charge director, may be utilized for
2 electrostatic imaging purposes.

3 Liquid toner compositions of the invention which
4 incorporate the inventive polymer blends necessarily
5 contain organic carrier liquids, usually solvents. Typical
6 of such solvents, which are mentioned here for
7 illustrative purposes only, are insulating, nonpolar
8 liquids, preferably having a resistivity in excess of about
9 10^9 ohm-cm and a dielectric constant below about 3.0.
10 These solvents are generally hydrocarbons, preferably
11 aliphatic and more preferably isomerized aliphatic
12 hydrocarbons, as, for example, those marketed by Exxon
13 Corporation under such trade marks as Isopar-G, Isopar-H,
14 Isopar-L and Isopar-M, which meet the preferred resistivity
15 and dielectric requirements. Alternatively, other liquids
16 having the preferred resistivity and dielectric
17 requirements, e.g. light mineral oils, such as those
18 manufactured by the Humble Oil and Refining Company under
19 the trade marks Marcol 52 and Marcol 62, may be used. A
20 further suitable solvent is marketed as "Penetec" (Penreco,
21 Butler, Pa.) described by the manufacturers as a
22 technical white mineral oil, of flash point 129°C,
23 viscosity 38/42 (SUS at 100°F) and 3.4/4.7 (CST at 40°C)
24 when measured according to ASTM D 445, specific
25 gravity .808/.818 at 60°F and API 41.5/43.6, measured
26 according to ASTM D 1298.

27 Blends of 75% Surlyn and 25% Elvax terpolymer were
28 made up into liquid toners and used in a liquid toner
29 imaging system incorporating an intermediate transfer
30 member. Using these toners, a good transfer to the
31 intermediate transfer member was obtained, as well as a
32 good transfer from the latter to both XEROX paper and
33 printers stock at optimal intermediate transfer member
34 temperatures between 45°C and 70°C, depending on the blend,
35 with optimal temperatures for the Surlyn 9020 based toners
36 having an optimum intermediate transfer temperature of
37 between 45° and 50°C and the Surlyn 1601 based materials
38 having an optimal intermediate transfer member temperature



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1 of 60°-70°C. In this example, the image was soft in
2 presence of carrier liquid, but good fixing was obtained by
3 evaporation of the carrier in an additional fusing/fixing
4 step. It is believed, however, that using other polymer
5 blends within the scope of the invention will enable harder
6 images to be obtained, thus avoiding the necessity for the
7 additional fusing/fixing step.

8 The specific preferred toners which are disclosed
9 herein are preferably produced as follows. 1000 grams of
10 polymer material in the required proportions and 1000 grams
11 of Isopar-L are mixed at low speed in a jacketed double
12 planetary mixer connected to an oil heating unit set at
13 170°C for one hour. 2000 grams of Isopar L, preheated to
14 $\approx 110^{\circ}\text{C}$ is added to the mix and the whole is mixed for a
15 further hour at high speed. The material is allowed to cool
16 in the mixer until it reaches $\approx 70^{\circ}\text{C}$ at which time it is
17 discharged from the mixer into aluminum pans. The material
18 is cooled to room temperature and is shredded and passed
19 through a meat grinder to produce a coarsely ground
20 material. Approximately 1050 grams of the coarsely ground
21 material, 66 grams of Mogul-L carbon black (Cabot) and 1200
22 grams of Isopar L are charged into a S1 attritor (Union
23 Process) and milled by 3/16" carbon steel balls for 10
24 hours with water cooling ($\approx 20^{\circ}\text{C}$). The resultant toner
25 particles have a median (by weight) diameter of about 2 μm .
26 The resultant material is diluted to a non-volatile solids
27 content of 1.5%, using Isopar L. Charge directors as known
28 in the art are added to charge the toner particles.
29 Preferably, the charge directors described in commonly
30 assigned U.S. patent application 7/354,121, filed May 22,
31 1989, or U.S. patent application 7/533,765, filed on June
32 6, 1990, the disclosures of which are incorporated herein
33 by reference, may be used.

34 Reference will now be made to Fig. 5 which illustrates
35 imaging apparatus, in which the electrostatic imaging
36 process of the invention employing the liquid toners of the
37 invention (including the inventive polymer blends), may be
38 carried out. The operation of this apparatus is described



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1 in the context of liquid developer systems with negatively
2 charged particles and positively charged photoreceptors,
3 but the invention may also be applied to other combinations
4 of toner charge and photoreceptor charge.

5 The apparatus of Fig. 5 comprises a drum 10 arranged
6 for rotation about axle in the direction indicated by arrow
7 14. Drum 10 is formed with a cylindrical photoreceptor
8 surface 16, preferably selenium based or organic
9 photoconductors. When the apparatus is activated, drum 10
10 begins to rotate and a charger 18 is operative to generally
11 uniformly charge surface 16 with a positive charge,
12 typically of the order of 1000 volts. Continued rotation
13 of drum 10 brings charged surface 16 into image receiving
14 relationship with light source 19, for example a laser
15 scanner, which projects a desired image onto charged
16 surface 16, thereby selectively discharging this surface
17 and producing a latent image thereon. Typically, the
18 discharged areas of surface 16 have a voltage of 100-200
19 volts.

20 Continued rotation of drum 10 brings charged surface
21 16 bearing the electrostatic latent image into operative
22 association with developer unit 22, operative to apply a
23 liquid developer (toner) to develop the latent image. For
24 multicolor systems, unit 22 may comprise, for example, a
25 plurality of developers, one for each color, which are
26 selectively engaged with the photoreceptor surface, as
27 described e.g. in U.S. Patent No. 4,690,539, or a single
28 development station where the liquid toner is changed
29 between colors, or any other suitable development system.
30 Developer unit 22 includes apparatus (not shown) for
31 dispensing carrier liquid, toner particles and charge
32 director, each of which may be stored in separate dispenser
33 cans or reservoirs.

34 Following application of toner thereto, surface 16
35 passes a typically positively charged rotating roller 26,
36 preferably rotating in the direction indicated by arrow 28;
37 roller 26 functions as a metering roller which reduces the
38 thickness of liquid on surface 16. Typically, the spatial



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1 separation of roller 26 from surface 16 is about 50
2 microns, and the voltage on roller 26 is intermediate the
3 voltages of the latent image areas and of the background
4 areas on the photoreceptor surface.

5 Downstream of roller 26 there is preferably provided a
6 rigidizing roller 30, which is preferably resiliently urged
7 against surface 16; roller 30 is preferably formed of a
8 metal core having a covering of a slightly conductive
9 resilient material, as described, for example, in U.S.
10 Patent No. 3,959,574 or U.S. Patent No. 3,863,603. In a
11 preferred embodiment of the invention, an electrically
12 biased squeegee roller is used as roller 30. Roller 30 is
13 negatively charged to a potential of at least several
14 hundred volts, e.g. up to 2000 volts, generally with the
15 same sign as the charge on the pigmented toner particles,
16 so that it repels similarly charged pigmented particles and
17 causes them to more closely approach the image areas of
18 surface 16, thus compressing and rigidizing the image.

19 Downstream of rigidizing roller 30 there is provided
20 an intermediate transfer member 40, which rotates in a
21 direction opposite to that of surface 16, as shown by arrow
22 41, providing zero relative motion between their respective
23 surfaces at the point of propinquity. Intermediate
24 transfer member 40 is operative for receiving the toner
25 image from surface 16 and for transferring the toner image
26 to a receiving substrate 42, such as paper. Disposed
27 internally of intermediate transfer member 40 there may be
28 provided a heater 46, to heat intermediate transfer member
29 40. Transfer of the image to intermediate transfer member
30 40 is preferably aided by providing electrification of
31 intermediate transfer member 40 to a voltage of sign
32 opposite to that of the charged particles, thereby causing
33 transfer by electrophoresis. Various types of intermediate
34 transfer members are known, and are described, for example,
35 in U.S. Patent No. 4,684,238, PCT Publication WO 90/04216
36 and U.S. Patent No. 4,974,027, the disclosures of all of
37 which are incorporated herein by reference.

38 Following the transfer of the toner image to

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1 intermediate transfer member 40, photoreceptor surface 16
2 engages a cleaning station 49. This station may be any
3 conventional cleaning station, comprising e.g. cleaning
4 roller 50 which may comprise a suitable resilient material
5 such as foam polyethylene or neoprene. Cleaning roller 50
6 may be wetted by clean lubricating cleaning liquid, which
7 preferably comprises liquid developer from which all or
8 nearly all of the toner particles have been removed.
9 Cleaning roller 50 is driven so that its surface moves
10 oppositely to surface 16 at their nip, to provide scrubbing
11 action for removal of residual particles and carrier liquid
12 from photoreceptor surface 16. A scraper 56 completes the
13 removal of any residual toner which may not have been
14 removed by cleaning station 49. A lamp 58 completes the
15 cycle by removing any residual charge, characteristic of
16 the previous image, from surface 16.

17 While the invention has been described with regard to
18 imaging systems using intermediate transfer members, liquid
19 toners of the invention can also be advantageously used in
20 systems which provide direct transfer from photoreceptor
21 surface 16 to paper and subsequently fuse the image in a
22 separate fusing station.

23 While the present invention has been particularly
24 described, persons skilled in the art will appreciate that
25 many variations and modification can be made. Therefore,
26 the invention is not to be construed as restricted to the
27 particularly described embodiments, rather the scope,
28 spirit and concept of the invention will be more readily
29 understood by reference to the claims which follow.

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CLAIMS

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2 1. A polymer blend of at least two distinct polymer
3 components, the blend being characterized in that in a 40%
4 non-volatile mixture with a hydrocarbon liquid toner
5 carrier, it has, on a semi-logarithmic viscosity vs.
6 temperature cooling curve, a break-point at a temperature
7 below about 65°C at a viscosity of between about 3×10^5
8 centipoises and about 5×10^6 centipoises.

9

10 2. A polymer blend according to claim 1, wherein at least
11 one of said two distinct polymer components does not have,
12 in a 40% non-volatile mixture with a hydrocarbon liquid
13 toner carrier, on a semi-logarithmic viscosity vs.
14 temperature cooling curve, a break-point at a temperature
15 below about 65°C at a viscosity of between about 3×10^5
16 centipoises and about 5×10^6 centipoises.

17

18 3. A polymer blend according to claim 1, wherein at least
19 two of said two distinct polymer components do not have, in
20 a 40% non-volatile mixture with a hydrocarbon liquid toner
21 carrier, on a semi-logarithmic viscosity vs. temperature
22 cooling curve, a break-point at a temperature below about
23 65°C at a viscosity of between about 3×10^5 centipoises and
24 about 5×10^6 centipoises.

25

26 4. A polymer blend according to claim 1 or claim 2 wherein
27 said blend substantially comprises only two distinct polymer
28 components.

29

30 5. A polymer blend according to any one of the previous
31 claims wherein one of said polymer components is an ionomer
32 derived from ethylene/methacrylic acid copolymers and
33 another of said polymer components is an ethylene/vinyl
34 acetate/acid terpolymer.

35

36 6. A polymer blend according to any of the previous claims
37 wherein one of said polymers is present in a range of about
38 25%-80% and the other of said polymers is present in a range
39 of 20% to 75% by weight.

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2 7. A liquid toner for use in imaging processes which
3 comprises pigmented toner particles, at least one charge
4 director and a hydrocarbon liquid toner carrier, wherein the
5 polymer comprised in said particles is a blend according to
6 any of the preceding claims.

7

8 8. In an electrostatic imaging process utilizing a liquid
9 toner which includes pigmented toner particles, at least one
10 charge director and hydrocarbon liquid toner carrier, the
11 improvement which comprises utilizing the toner according to
12 claim 7.

13

14 9. An electrostatic imaging process according to claim 8
15 including the steps of:

16 forming an electrostatic image on an imaging surface;

17 developing the image with the liquid toner to form a
18 developed liquid toner image; and

19 transferring the developed liquid toner image to a
20 final substrate.

21

22 10. An electrostatic imaging process according to claim 9
23 wherein the step of transferring includes the steps of:

24 transferring the developed image from the imaging
25 surface to an intermediate transfer member; and

26 transferring the image from the intermediate transfer
27 member to the final substrate.

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