

INK JET PRINTING PAPER

This invention relates to a versatile ink-jet printing paper, i.e. to paper which is specially adapted to give good imaging performance when used with an ink jet printer, but which also exhibits good toner adhesion when imaged by electrophotographic processes as used in laser printers, xerographic copiers and such like.

Ink-jet printers will produce an image on most papers, but the print quality varies markedly in dependence on the nature of the paper used. By "print quality" is meant factors such as the sharpness, intensity and uniformity of the image produced and its susceptibility to smudging immediately or shortly after the ink has been applied. In the case of colour printing, it is important also that the colours should not run into one another and that they should be vivid, with good brightness.

Print quality is influenced by a number of factors, but the two most important are the extent to which the ink droplets spread out after contact with the paper and the rapidity with which the ink droplets are absorbed into the paper. Excessive droplet spreading resulting from, for example, flow of ink along the length of the paper fibres, produces an image which appears blurred, with fuzzy edges, spidery lines and a general lack of resolution (this is often referred to as feathering or wicking, and the effect is somewhat analogous to that obtained by writing with a fountain pen on blotting paper). Slow absorption of the ink into the paper can result in smudging of the image and in merging of ink from different droplets, giving ragged images and, if the ink droplets are of different colours, running of the colours into one another, often termed ink bleed.

Hitherto, it has generally been found necessary to apply a pigment coating to the paper in order to achieve top quality colour images, i.e. vivid bright colours which do not run into one another. The pigment coating makes the paper highly

absorptive to the aqueous ink vehicle, so that the vehicle drains away quickly into the body of the paper, leaving the coloured dye at the surface and thereby giving bright intense colours with minimal print bleed. Whilst pigment coating has not been found essential for good quality black (monochrome) images, it does generally enhance the quality of those images compared with those obtained on uncoated papers.

The use of a pigment coating is disadvantageous in certain respects, in that it adds to raw material and process costs, and tends to give rise to "dusting" problems in subsequent conversion and printing operations, i.e. pigment particles can become dislodged from the coating and deposit on reeling, slitting and printing equipment.

For papers for general office use, the cost of pigment coating is often not justified, and ordinary uncoated papers have been used. These have generally been hard sized in order to give good ink "hold-out", which produces bright colours and minimises strike-through and feathering (regardless of whether colour or monochrome inks are used). However, hard sizing can adversely affect toner adhesion when the paper is imaged with laser printers, xerographic copiers and such like. It is important to appreciate in this regard that the commercial need is for a versatile paper which offers good performance not just with respect to ink-jet printers but also to laser printers, xerographic copiers and such like. Many customers utilise a variety of types of printer, and they seek to obtain paper which works well on all these printers rather than being forced to use a different paper for each type of printer.

Good performance with a laser printer or similar requires that the paper should have a good affinity for the toners used to effect imaging, so that the toner adheres well to the paper. The adverse effect of hard sizing on toner adhesion can be particularly pronounced when sizing is achieved by the use of alkyl ketene dimer (AKD) sizing agents, possibly because AKD sizes are waxy in nature and can produce a release effect. Since AKD sizing offers the papermaker many benefits compared

with traditionally rosin-alum sizing, it is important that it should be possible to utilise AKD sizing in the production of papers for office use, and that a solution should be found to the problem of achieving good ink-jet printing performance and good toner adhesion in the same product.

Good toner adhesion is particularly difficult to achieve with rough papers which carry a surface-profile texture, for example a laid line, chain line or other pattern applied by means of a dandy roll, or a pattern applied by felt marking or wet or dry embossing. This is probably because toner adhesion is normally achieved by heat- and/or pressure-fusion of the toner to the paper. With rough or surface-textured papers, it is difficult to achieve sufficiently good physical contact for this fusion to be effective.

It is an object of the present invention to overcome or at least reduce the problems described above and to provide an improved ink jet printing paper which gives good colour and monochrome images without the need for a full pigment coating of the conventional kind, and which, particularly when the paper has a surface-relief texture, is also capable of good quality imaging by electrophotographic processes as used in laser printers, xerographic copiers and such like.

We have now found that the above-stated object can be achieved by treating a suitable base paper with a composition comprising an admixture of:

- (a) a cooked and/or chemically modified starch;
- (b) a hydrophilic polymer other than a starch; and
- (c) a hydrophobic polymer.

Accordingly, the present invention provides, in a first aspect, an ink-jet printing paper of which the print-receiving surface comprises a base paper treated with a composition comprising an admixture of:

- (a) a cooked and/or chemically modified starch;
- (b) a hydrophilic polymer other than a starch; and
- (c) a hydrophobic polymer.

In a second aspect, the present invention provides a method of producing ink-jet printing paper, comprising the step of treating at least the print-receiving surface of a base paper with a composition comprising an admixture of:

- (a) a cooked and/or chemically modified starch;
- (b) a hydrophilic polymer other than a starch; and
- (c) a hydrophobic polymer.

The treatment composition is conveniently applied to the paper by means of a size press, but other techniques can be used, for example spraying or coating. The expression "size press" in this context includes modified size presses or coating heads as supplied, for example, by Voith under the name "Speedsizer", Valmet under the name "Sym-sizer", Jagenberg under the name "Filmpress" and BSG under the name "Twin HSM".

Cooked and/or chemically modified starches are widely used in the paper industry and are thus very well-known. They are to be distinguished from particulate starches as found in plants (such particulate starches are the raw material from which cooked and/or chemically modified starches are produced). Dextrins, although derived from starches, are not considered to be "cooked and/or chemically modified starches" in this context, since the hydrolysis processes involved in their production result in loss of essential starch character.

Suitable starches for use in the treatment composition are generally those used in the paper industry as surface sizes, as coating binders, or as wet-end additives. Surface-sizing starches are currently preferred. The starches can be anionic, cationic, amphoteric or non-ionic in character. A preferred surface sizing starch for use in the present invention is an anionic oxidised potato-based starch. Other suitable surface sizing starches are oxidised maize or wheat

starches.

The hydrophilic polymer for use in the treatment composition is preferably a polyvinyl alcohol, more preferably a relatively low molecular weight partially-hydrolysed polyvinyl alcohol with a degree of hydrolysis of around 88%, or 87-89% as it is often expressed in manufacturer's product information sheets. Other hydrophilic polymers which can be used include dextrin, cellulose derivatives such as carboxymethyl cellulose (CMC) and hydroxyethyl cellulose (HEC); gelatin; vegetable gums such as gum arabic; polyvinylpyrrolidones; and maleic anhydride copolymers, for example copolymers of maleic anhydride with ethylene (EMA), or vinyl methyl ether (PVME).

The hydrophobic polymer for use in the treatment composition is preferably a latex, typically a latex of the kind supplied for use as a paper coating binder or as a surface sizing additive. Suitable latexes include styrene-acrylic copolymer latexes of various kinds (including acrylonitrile/n-butylacrylate/styrene copolymer latex); styrene-butadiene copolymer latexes; and polyurethane latexes.

The relative proportions of the starch, hydrophilic polymer and hydrophobic polymer can vary quite widely, although the starch is normally the major component of the composition, usually making up at least 50% of its total weight on a dry basis. The amount of hydrophobic polymer present can vary quite widely, depending on the degree of hydrophobicity of the polymer. For example, the amount of hydrophobic polymer required when the polymer is a polyurethane is much less than when the polymer is a styrene-acrylic or carboxylated styrene-butadiene material. Detailed guidance as to suitable relative proportions of the various mix components can be gained from the specific examples given hereafter, but in general terms, the treatment composition should contain from about 50 to about 90% by weight starch, from about 5 to about 50%, more preferably 5 to 25%, by weight of a hydrophilic polymer such as polyvinyl alcohol, and from about 2 to about 40% of

hydrophobic polymer, all these percentages being on a dry basis. Whilst the amount of polyvinyl alcohol used can vary quite widely, as indicated, cost factors would normally lead to usage in the lower part of the range quoted. The amount of hydrophobic polymer used will depend in part on its degree of hydrophobicity. In general the amount used will be in the range 2 to 30% by weight. Typically the treatment composition is made up at a solids content of about 5 to about 15% by weight, although this is not believed to be critical.

If desired, the treatment composition can include a small proportion of pigment such that the weight of pigment in the composition is less, normally much less, than the aggregate dry weight of the starch, the hydrophilic polymer and the hydrophobic polymer. The weight ratio of pigment : aggregate dry weight of starch, hydrophilic and hydrophobic polymer may be, for example, about 1:20, although the precise ratio is not thought to be critical. The inclusion of a minor proportion of pigment in this way can in some cases enhance the ink-jet printing performance of the paper still further. The use of a minor proportion of pigments to enhance the effect of the present composition is to be contrasted with the use of conventional pigment coatings, in which the pigment normally predominates (a typical pigment : binder ratio for such coatings might be of the order of 4:1 to 8:1).

The present treatment composition can be used to enhance the ink-jet printing performance of a wide variety of papers for office or other business use. Typically however, the base paper is an around 80 to 100 g m⁻² woodfree base which has been conventionally internally sized, for example with alkyl-ketene dimer or a rosin/alum sizing system. Hard sizing is preferable, for example to a Cobb value (60 seconds) in the range 15 to 30. The pulps used and their relative proportions can vary widely, but a typical furnish would comprise 80% hardwood pulp and 20% softwood pulp. Usual papermaking fillers and other additives can be present.

The treatment composition is preferably present in an amount of 1 to 5%, more preferably 2 to 4%, by weight of the base paper on a dry basis. Thus for a 100 g m^{-2} base paper to which the treatment composition is applied by means of a size press, the dry pick-up should preferably be from about 2 g m^{-2} to 4 g m^{-2} , on a dry basis (i.e. 1 or 2 g m^{-2} per side). Higher pick-up levels are technically acceptable but may be economically disadvantageous.

The paper can be preferably calendered after treatment and subsequent drying, for example to a Bendsten roughness value of 500 ml min^{-1} or less. Alternatively the paper can be one which carries a surface-profile texture as referred to earlier.

The reasons why the use of the present treating composition gives good results are not yet fully understood. However, we believe the presence of the hydrophobic polymer causes the ink, which is normally aqueous in nature, to be better "held out" on the surface of the paper - if hydrophobic polymer is omitted, the ink penetrates the paper structure too rapidly and dull and ragged print images are obtained.

The polyvinyl alcohol or other hydrophilic polymer on the other hand promotes a controlled penetration of the ink but without much lateral spreading. If hydrophilic polymer is omitted, penetration is poor and the ink drying time is too long and an undesirable degree of mottle results. Thus although bright colours may be obtained, differently-coloured inks remain on the paper surface for sufficient time to run into and merge with one another, i.e. print bleed occurs. This is not a problem with monochrome inks, but the tendency of the ink to stay at the paper surface may give rise to smudging of the image.

Thus in summary, the benefits of the present invention are thought to accrue from the presence of a complementary balanced combination of hydrophilic and hydrophobic elements. The starch component of the composition is thought to

contribute primarily the normal benefits of a starch sizing agent, i.e. it fills in pores and voids at the sheet surface and thereby provides a physical impediment to liquid penetration, sticks down loose fibres, and enhances the strength of the final paper.

The invention will now be illustrated by the following Examples, in which an asterisk indicates the first occurrence of a proprietary trade mark, all parts and percentages are by weight unless otherwise stated, and which provide details of additional specific benefits which have been achieved by the invention with particular types of paper:

EXAMPLE 1

55 parts of anionic oxidised potato starch ("Perfectamyl" P 255 SH" supplied by Tunnel Avebe, of Ulceby, South Humberside, United Kingdom) and 15 parts of an 88 Mol% hydrolysed relatively low molecular weight polyvinyl alcohol ("Mowiol" 8-88" supplied by Harlow Chemical Company Limited of Harlow, Essex, United Kingdom) were blended as dry powders. The blend was then made up into an approximately 10% solids content aqueous solution/dispersion and cooked at about 90°C for 30 minutes. After allowing the mixture to cool to about 50°C, 60 parts of 50% solids content (i.e. 30 dry parts) of acrylonitrile/n-butylacrylate/styrene copolymer latex ("Acronal" S 360 D" supplied by BASF) were added with stirring, to give a treatment composition of a little under 15% solids content and a viscosity of about 80 cps (measured at 20°C, Brookfield viscometer, Spindle No. 2, speed 100 rpm).

This treatment composition was then applied to a sheet of 100 g m² white uncoated woodfree general office base paper using a laboratory size press. The base paper was internally sized with alkyl ketene dimer, but had not previously been surface sized. The treated sheet was then dried using a laboratory rotary dryer. The dry pick-up was found to be about 5% (i.e. about 2.5 g m² per side), based on the dry weight of the base paper before treatment. The treated paper

had a 60 second Cobb value of 18. The treated sheet was then laboratory calendered. After calendering the sheet had a Bendsten roughness of 150 ml min⁻¹.

The sheet and a control sheet which had been treated with a conventional starch sizing composition were then printed by means of a Hewlett Packard Deskjet 560C ink jet printer. The printed images were of a standard test card giving both colour and monochrome (black) images and specifically designed to evaluate print quality and reveal failings in intensity, sharpness, wicking, print bleed and such like.

The paper according to the invention was found to give rapid ink drying--(i.e. penetration into the paper), good colour intensity, low ink bleed, and sharply defined colour and monochrome characters, with little wicking and low mottle, i.e. non-uniformity in print intensity in different areas of the paper. There was little or no strike-through of the ink to the reverse (unprinted) surface of the sheet.

By comparison, the control sheet showed more print bleed and less bright colours on colour-printed areas. The monochrome image quality was quite good (probably a consequence of the internal sizing of the paper) but had a longer "drying time". This would be likely to give rise to smudging in everyday use.

EXAMPLE 2

This illustrates the use of three alternative hydrophobic polymers to that used in Example 1. These were as follows:

- | | | |
|--------|---|--|
| Mix I | - | polyurethane latex supplied at 20% solids content by Akzo Nobel under the name "Cyclopal" AP" |
| Mix II | - | styrene/acrylic copolymer latex supplied at 27% solids content by Akzo Nobel under the name "Bewopress" AE 27" |

Mix III - carboxylated styrene/butadiene copolymer latex supplied at 50% solids content by Dow Chemical under the name "Dow" DL 950"

The other mix components were the same starch and polyvinyl alcohol as used in Example 1. The treatment compositions were prepared by the same general procedure as described in Example 1, but the final solids content was a little lower (about 12%). The % dry composition of the compositions was as follows:

<u>Component</u>	<u>Mix I</u>	<u>Mix II</u>	<u>Mix III</u>
Starch	77.5	55	55
Polyvinyl alcohol	20.0	15	15
Latex	2.5	30	30

The polyurethane has a higher degree of hydrophobicity than the other two polymers, and so it was used in a much smaller quantity.

Each treatment composition was applied to a respective sheet of 95 g m² white uncoated woodfree premium business stationery base paper which had been internally hard sized with alkyl ketene dimer, but which had not been surface sized. The dry pick-up was found to be about 4% (i.e. about 2 g m² per side). After drying, the sheets were each laboratory calendered to a Bendsten roughness of around 150 ml min⁻¹.

The various sheets, together with a control sheet which was conventionally starch-sized, were then printed and evaluated as described in Example 1. All three papers according to the invention were found to give the same good performance as described in detail in Example 1, and the same benefits over the control paper.

EXAMPLE 3

This illustrates the use of the present invention on a full-size papermachine, using a treatment composition with the same ingredients and relative proportions as set out in detail in Example 1 (55 parts anionic oxidised potato starch, 15 parts 88 Mol% hydrolysed low molecular weight polyvinyl alcohol, and 30 parts latex, all on a dry basis). The solids content of the composition was 12%.

An 80% hardwood/20% softwood furnish internally sized with alkyl ketene dimer and containing usual papermaking fibres and additives was used to produce a good quality very smooth white woodfree general office paper. The treatment composition described above was applied at the size press and the paper was conventionally calendered after drying. The final paper had a basis weight of 105 g m², topside and wireside Bendsten roughnesses of 66 and 44 ml min⁻¹ respectively, a 60 second Cobb value of 25 and a filler content of about 15% (urea-formaldehyde resin synthetic filler).

The paper, and a control paper of the same type sized only with a conventional starch size press formulation were then evaluated for ink jet performance generally as described in previous Examples.

Toner adhesion was also evaluated. The toner adhesion test, also known as the tape pull test, involved printing a solid block of toner onto each sheet by means of a Hewlett-Packard LASERJET[®] IV laser printer; measuring the print density by means of an image intensity measuring instrument; applying adhesive tape to the sheet over the block-imaged area; carefully removing the tape with the aid of an Instron peel force tester to ensure an even and reproducible removal force; and re-measuring the print density. The ratio of the print density after removal of the tape to the print density before application of the tape is then expressed as a percentage value termed the "toner adhesion".

The results of the tests were as follows:-

<u>Property</u>	<u>Invention</u>	<u>Control</u>
Colour appearance	good	mottled
Colour brightness (see note 1)	10.1	14.3
Colour intensity (see note 2)	1.1	0.8
Colour print bleed	good	poor
Monochrome wicking	good	acceptable
Monochrome optical density (see note 4)	1.6	1.6
Monochrome ink drying time (see note 3)	39 sec	68 sec
Toner adhesion (%)	93	74

NOTES

1. Measured according to an optical reflectance test method in which the lower the number obtained, the better the brightness and for which any value higher than 12 is deemed unacceptable.
2. Measured according to a Hewlett Packard standard test in relation to a composite black image derived by printing the same area with several different coloured inks and for which the higher the number obtained, the better the intensity, with a value of 0.8 being the threshold of acceptability.
3. Measured according to a Hewlett Packard standard test.
4. Measured using a Gretag* optical densitometer, with a value of 1.2 being an approximate threshold of acceptability.

It will be seen that the paper according to the invention was markedly better in most respects than the control paper.

In a later repeat making of the same type of paper, the starch used was a mill-cooked potato-based starch. The same product benefits were obtained.

EXAMPLE 4

This illustrates the use of the present invention on a full-size papermachine making a less smooth paper than in the case of Example 3 above.

The procedure was generally as described in Example 3, except that the refining conditions were different, the solids content of the treatment composition was 10% and precipitated calcium carbonate was used as the filler rather than urea-formaldehyde resin synthetic pigment. The final paper had a basis weight of 101 g m², topside and wireside roughnesses of 195 and 132 ml min⁻¹ respectively, a 60 second Cobb value of 27 and a filler content of about 11%.

The results of the ink jet printing performance evaluation for the product according to the invention and an approximate control paper were as follows:

<u>Property</u>	<u>Invention</u>	<u>Control</u>
Colour appearance	good	mottled
Colour brightness	9.7	8.3
Colour intensity	1.3	1.7
Colour print bleed	good	very poor
Monochrome wicking	good	good
Monochrome optical density	1.8	1.8
Monochrome ink drying time	8 sec	23 sec
Toner adhesion	73%	28%

It will be seen that the paper according to the invention performed better than the control paper in terms of colour appearance, colour print bleed and ink drying time. The control paper was slightly better in terms of colour brightness and intensity, probably because the control paper was very hard sized, but these marginal benefits are

completely outweighed by the severe print bleed, the mottled appearance and the high drying time of the control paper.

EXAMPLE 5

This illustrates the use of a range of different hydrophilic polymers in the treatment composition (these include an 88 Mol % hydrolysed polyvinyl alcohol as used in previous Examples). In each case, the treatment composition on a dry basis was as follows:

Starch ("Perfectamyl P 255 SH")	85%
Hydrophilic polymer (see below)	9%
Latex ("Bewopress AE 27")	6%

Four different treatment compositions were prepared, the hydrophilic polymers used being as follows:

Mix I	-	88 Mol % hydrolysed polyvinyl alcohol ("Mowiol 8-88")
Mix II	-	Polyvinylpyrrolidone ("Lumiten" PR 8450") supplied in 30% aqueous solution by BASF)
Mix II	-	Low molecular weight carboxymethyl cellulose ("Finnfix" 5" supplied by Metsa-Serla, Finland)
Mix IV	-	Fully hydrolysed polyvinyl alcohol ("Mowiol 10-98" supplied by Harlow Chemical Company)

Each treatment composition was applied to respective sheets of test paper as used in Example 2, and then dried and calendered, also as described in Example 2. The various sheets, together with a control sheet which was conventionally starch-sized, were then printed and evaluated as described in Example 3.

The results were as follows:

<u>Property</u>	<u>Control</u>	<u>Mix I</u>	<u>Mix II</u>	<u>Mix III</u>	<u>Mix IV</u>
Monochrome wicking	A	A	A	A	A
Monochrome optical density	1.5	1.6	1.7	1.7	1.8
Monochrome ink drying time (sec)	15	15	22	15	25
Colour appearance	G	G	G	G	G
Colour brightness	6.6	6.2	6.6	7.1	6.7
Colour print bleed	A	E	E	G	G
Toner adhesion (%)	58	86	67	74	78

Key: A = Acceptable

G = Good

E = Excellent

It will be seen that papers according to the invention showed improved colour print bleed and monochrome optical density performance, and much better toner adhesion compared with the control paper.

EXAMPLE 6

This illustrates the use of the present invention for treating a 100 g m² laid premium business stationery paper during its manufacture on a full-sized papermachine. The paper was internally AKD-sized and incorporated a ca. 15% precipitated calcium carbonate loading. The procedure was generally described in Example 3, and the final paper had a 60 second Cobb value of 24.

The results of the tests were as follows:

<u>Property</u>	<u>Invention</u>	<u>Control</u>
Colour appearance	good	good
Colour brightness	6.6	7.2
Colour intensity	1.6	1.4
Colour print bleed	good	poor
Monochrome wicking	good	good
Monochrome optical density	1.8	1.8
Monochrome ink drying time	13 sec	24 sec
Toner adhesion (%)	92	51

It will be seen that the paper according to the invention had improved colour brightness and colour print bleed, a shorter ink drying time and much improved toner adhesion, compared with the control paper.

EXAMPLE 7

This illustrates the use of a different type of starch in the treatment composition, namely a wheat (carbohydrate extract) starch supplied as "Abrastarch" (at 9% solids content) by ABR Foods Limited, Corby, England, in place of the "Perfectamyl P 255 SH" starch used in previous Examples.

The procedure was generally as described in Example 3, except that the treatment composition was as follows:

Starch	85%
Polyvinyl alcohol ("Mowiol 8-88")	9%
Latex ("Bewopress AE 27")	6%

The total dry pick up of the composition was ca. 4 g m^{-2} (4%) and the 60 second Cobb value was 24. The Bendsten roughness of both surfaces of the paper was in the range $50 - 60 \text{ ml min}^{-1}$.

The test results were as follows (no colour intensity measurements were made for this and subsequent Examples):

<u>Property</u>	<u>Invention</u>	<u>Control</u>
Colour appearance	no mottle	mottled
Colour brightness	13	13
Colour print bleed	good	poor
Monochrome wicking	good	good
Monochrome optical density	1.7	1.7
Monochrome ink drying time	17 sec	20 sec
Toner adhesion (%)	99	57

It will be seen that the paper according to the invention had improved colour appearance, improved colour print bleed and much improved toner adhesion compared with the control paper.

EXAMPLE 8

This illustrates the effect of omitting the hydrophilic polymer from the treatment composition. Three treatment compositions were evaluated, as follows (dry basis):

Invention	:	Starch ("Abrastarch")	85%
		Polyvinyl alcohol ("Mowiol 8-88")	9%
		Latex ("Bewopress AE 27")	6%
Control I	:	Starch (as above)	94%
		Polyvinyl alcohol (as above)	6%
Control II	:	Starch (as above)	100%

These compositions were each applied to a relatively rough flecked 100 g m² decorative text and cover paper during its production on a full-size papermachine. The resulting papers were tested as in Example 7, and the results obtained were as follows:

<u>Property</u>	<u>Invention</u>	<u>Control I</u>	<u>Control II</u>
Colour appearance	acceptable	acceptable	acceptable
Colour brightness	11	10	10
Colour print bleed	excellent	acceptable	acceptable
Monochrome wicking	acceptable	acceptable	acceptable
Monochrome optical density	1.5	1.6	1.6
Monochrome ink drying time	12 sec	14 sec	11 sec
Toner adhesion (%)	77	36	23

It will be seen that the paper according to the invention had improved colour print bleed and much improved toner adhesion compared with the control paper. Accurate comparison of properties such as appearance (mottle) and colour brightness was hindered by the decorative flecked appearance of the paper.

EXAMPLE 9

This illustrates the use of a minor proportion of pigment in the treatment composition. The pigment used was calcium carbonate ("Hydrocarb" 90", supplied by Croxton & Garry, Dorking, England) and was present in the treatment composition in an amount of 5% calculated as dry weight of pigment to aggregate dry weight of starch, hydrophilic polymer and hydrophobic polymer. This treatment composition and general procedure were otherwise as in Example 3. Additionally, paper was produced using the same treatment composition without pigment and, separately, with a 100% starch treatment composition.

<u>Property</u>	<u>Invention</u> <u>(without Pigment)</u>	<u>Invention</u> <u>(with Pigment)</u>	<u>Control</u>
Colour appearance	no mottle	no mottle	slight mottle
Colour brightness	11.2	12.0	11.6
Colour print bleed	good	acceptable	poor
Monochrome wicking	good	good	good
Monochrome optical density	1.7	1.6	1.6
Monochrome ink drying time (sec)	23	36	43
Toner adhesion (%)	90	90	60

It will be seen that both papers according to the invention had improved colour appearance, improved colour print bleed, shorter ink drying time and much improved toner adhesion compared with the control paper.

EXAMPLE 10

This illustrates the use of the invention with an acid sized (rosin/polyaluminium chloride) paper produced on a full-sized papermachine. The paper was a very smooth high quality white 100 g m² woodfree business stationery paper containing a ca. 15% precipitated calcium carbonate loading. The treatment composition, made up at 8% solids content, was as follows:

Cationic etherified starch	82%
("Amylopak" 15", supplied by Tunnel Avebe Limited, England)	
Polyvinyl alcohol ("Mowiol 8-88")	10%
Styrene-acrylic latex ("Bewopress AE 27")	8%

The final paper had a 60 second Cobb value of 26, and topside and wireside smoothness values of 60 ml min⁻¹ and 50 ml min⁻¹ respectively (Bendsten). The dry pick up of the treatment composition was ca. 4%, i.e. ca. 2 g m² per side.

CLAIMS:

1. Ink-jet printing paper of which the print-receiving surface comprises a base paper treated with a composition comprising an admixture of:
 - (a) a cooked and/or chemically modified starch;
 - (b) a hydrophilic polymer other than a starch; and
 - (c) a hydrophobic polymer.
2. Ink-jet printing paper as claimed in Claim 1 wherein the starch makes up at least 50% by weight of said composition on a dry basis.
3. Ink-jet printing paper as claimed in Claim 2, wherein the treatment composition contains, on a dry basis, from 50 to 90% by weight, preferably 50 to 80% by weight, starch; from 5 to 50% by weight, preferably 5 to 25% by weight, of hydrophilic polymer; and from 2 to 40% by weight, preferably 2 to 30% by weight, of hydrophobic polymer.
4. Ink-jet printing paper as claimed in any preceding claim wherein the treatment composition is present in an amount of 1 to 5% by weight, preferably 2 to 4% by weight, of the base paper on a dry basis.
5. Ink-jet printing paper as claimed in any preceding claim, wherein the starch is a surface-sizing starch.
6. Ink-jet printing paper as claimed in any preceding claim, wherein the hydrophilic polymer other than starch is a polyvinyl alcohol.
7. Ink-jet printing paper as claimed in Claim 6, wherein the polyvinyl alcohol is a relatively low molecular weight polyvinyl alcohol with a degree of hydrolysatation of 87 to 89 Mol %.



8. Ink-jet printing paper as claimed in any preceding claim wherein the hydrophobic polymer is a latex.
9. Ink-jet printing paper as claimed in Claim 5 wherein the latex comprises an acrylonitrile/n-butylacrylate/styrene copolymer latex; a styrene/acrylic copolymer latex other than the foregoing; a styrene-butadiene copolymer latex; or a polyurethane latex.
10. Ink-jet printing paper as claimed in any preceding claim wherein the composition includes a pigment in a small proportion relative to the aggregate dry weight of the starch, the hydrophilic polymer and the hydrophobic polymer.
11. A method of producing ink-jet printing paper, comprising the step of treating at least the print-receiving surface of a base paper with a composition comprising an admixture of:
 - (a) a cooked and/or chemically modified starch;
 - (b) a hydrophilic polymer other than a starch; and
 - (c) a hydrophobic polymer.
12. The use, for the purpose of enhancing the print quality obtained when printing paper by ink-jet printing processes, and also electrophotographic processes, of a treatment composition comprising an admixture of:
 - (a) a cooked and/or chemically modified starch;
 - (b) a hydrophilic polymer other than a starch; and
 - (c) a hydrophobic polymer.

This Sheet Has Been Replaced

* C L M S *