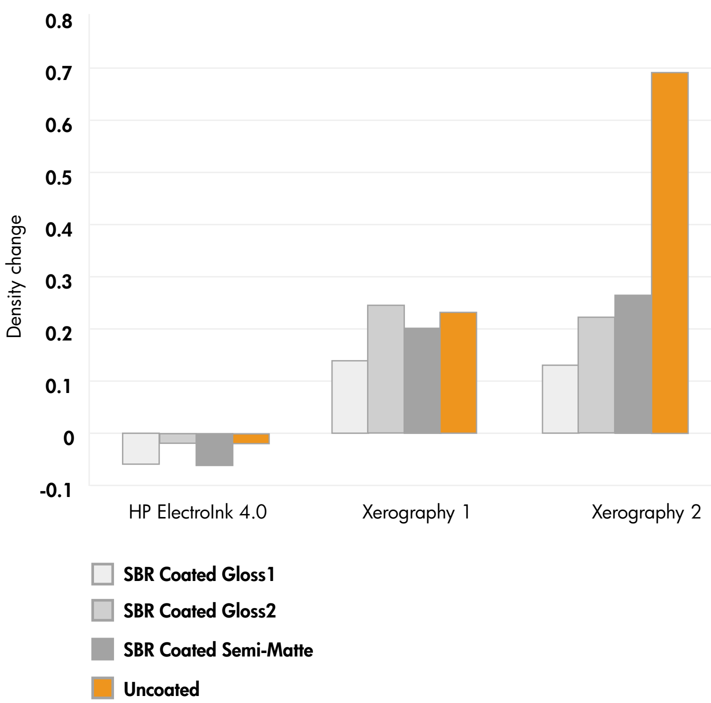
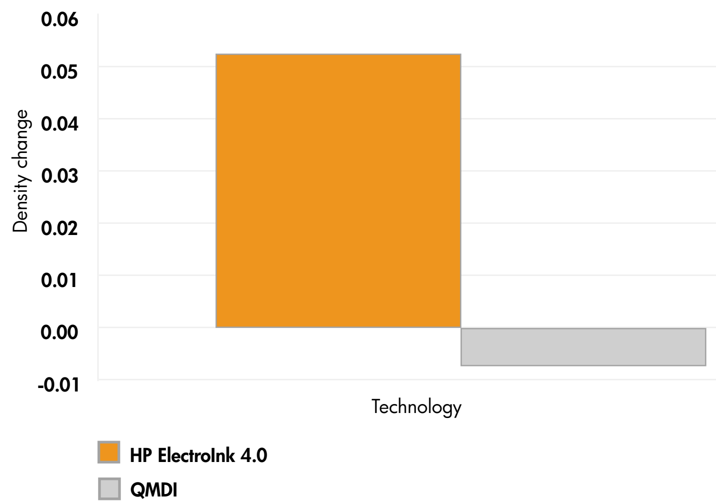
HP ElectroInk
Frequently Asked Questions

For customers using HP ElectroInk 4.0

Sutherland rub-resistance tests
Change in image density (HP ElectroInk vs. Xerography)



Sutherland rub-resistance tests
Change in image density (HP ElectroInk vs. Offset) on SBR Coated Gloss



What is HP ElectroInk?

HP ElectroInk is a unique liquid ink (Liquid EP) that combines the advantages of electronic printing with the qualities of liquid ink. HP ElectroInk contains charged pigmented particles in a liquid carrier. Like other digital printing technologies, i.e. Dry EP (or Xerography), HP ElectroInk enables digital printing by electrically controlling the location of the print particles. However, unlike Dry EP, HP ElectroInk enables very small particle size, down to 1-2 microns. HP ElectroInk is supplied as a concentrated paste that is loaded into the press in tubular cartridges in a 'clean hands' operation. Inside the press it is fed into ink supply tanks and diluted with oil, to form a fluid mixture of carrier liquid and colorant particles ready for printing.

How does HP ElectroInk support the performance required for high quality, digital color printing?

The small particle size in the liquid carrier enables high resolution, uniform gloss, sharp image edges, and very thin image layers which closely follow the surface topography of the paper resulting in a highly uniform finish complementing that of the paper.

How does HP ElectroInk's rub resistance rate?

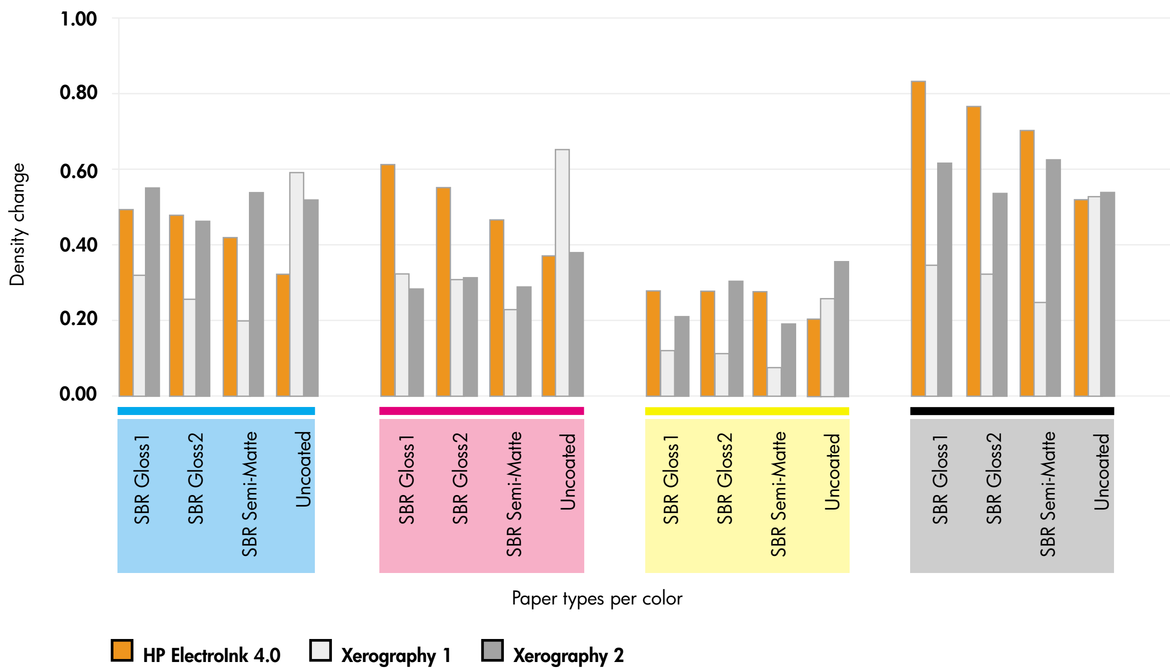
HP ElectroInk's rub-resistance is characterized by employing a test procedure that measures the ink density on the printed surface before and after the test. The measured difference in density defines the amount of loss of print image accrued during the test – the greater this number, the greater the loss. The printed image is rubbed against the same kind of non-printed substrate using the Sutherland Ink Rub Tester (www.rubtester.com) with a 4 pound weight (1.8 kilograms) for 440 strokes.

The test for rub resistance was performed by the Rochester Institute of Technology (www.rit.edu) under laboratory conditions as a simulation of on-site printing according to ASTM D5264-98 (2004) "Standard Practice for Abrasion Resistance of Printed Materials by the Sutherland Rub Tester", and according to Tappi Test Method T 830 om-04 "Ink Rub Test of Container Board".

The tests were performed on four different types of substrates, simulating accepted types of coated and uncoated gloss and matte papers. Print samples were taken from the HP Indigo press using HP ElectroInk 4.0 as well as the Xerox iGen3, the Kodak Nexpress and the Heidelberg QMDI.

According to the test results from the Rochester Institute of Technology "HP ElectroInk 4.0 had the highest resistance" in comparison to the Xerography technologies, as can be seen in the charts above.

Change in image density per color, before and after Taber abrasion test



How does HP ElectroInk's resistance to abrasion rate?

HP ElectroInk's resistance to abrasion is characterized by employing a test procedure that measures the ink density on the printed surface before and after the test. The measured difference in density defines the amount of loss of print image accrued during the test – the higher this number, the greater the loss. The printed specimens are mounted on a rotating turntable using the Taber Abraser Model 5130 (www.kencopress.com) and subjected to the wearing action of two abrasive wheels, which are applied at a specific pressure. 20 cycles were used for this test.

The test for abrasion resistance was performed by the Rochester Institute of Technology (www.rit.edu) under laboratory conditions as a simulation of on-site printing according to Tappi Test Method T 476 om-01 "Abrasion Loss of Paper and Paperboard (Taber-Type Method)".

The tests were performed on four different types of substrates, simulating accepted types of coated and uncoated gloss and matte papers. Print samples were taken from the HP Indigo press using HP ElectroInk 4.0 as well as the Xerox iGen3, the Kodak Nexpress and the Heidelberg QMDI.

According to the test results from the Rochester Institute of Technology, HP ElectroInk 4.0 performance varied in comparison to the other technologies tested with regards to each specific color, as can be seen in the chart above.

Do images printed with HP ElectroInk show any variation in color values during a print run?

Images printed with HP ElectroInk were analyzed after a print run of 100,000 impressions, and measured for a change in color. The analysis found no variation in color values of the xth print compared to the 1st print ($\Delta E^* < 2$).

Does HP ElectroInk that has been stored[1] for a period of time undergo any degradation of color values?

The HP ElectroInk was analyzed after one year of storage and measured for a change in color. The analysis found no degradation in color values ($\Delta E^* < 3$)[2].

[1]HP ElectroInk must be stored according to approved HP storing conditions

[2]DeltaE* expresses the color change between the X print to the 1st print at the same optical density. The optimal result is when DeltaE* is close to zero.

How effective is HP ElectroInk's ability to withstand exposure to light?

HP ElectroInk's ability to withstand exposure to light is measured by utilizing various tests for lightfastness. Lightfastness is a term used to describe the resistance of a material to color change when exposed to sunlight or to artificial light sources. The lightfastness tests employed in order to achieve the results listed below, evaluate the print's resistance to ultraviolet light by comparing the measure of change that has occurred between an exposed area and an unexposed area. A Xenon Arc lamp is used in these tests since it contains a special gas, xenon, which produces an intense light that accelerates the color fading reaction. Since the Xenon Arc lamp reproduces full-spectrum light (as found in sunlight), it is useful for fade and color change testing of inks and media.

Two separate tests of lightfastness are shown below. The first shows results based on a Blue Wool reference scale, while the second shows results based on changes in optical density (determined by the percentage of noticeable fading) and changes to color coordinates (measured by the variation in deltaE*).

Lightfastness test1: Blue Wool

The lightfastness test was performed using a Xenon Arc UV lamp, under the following standards:

- British Standard BS-1006B02 for indoor conditions
- ISO 4892-1 Plastics – methods of exposure to laboratory light sources, method B, indoor behind window glass according to colorfastness to light (Xenon Arc)
- ISO 105 B02 – colorfastness to light (Xenon Arc)

The results are presented on a 1-8 Blue Wool reference scale.

Blue Wool test results

Type	Brand	HP ElectroInk 4.0				Testing standard used
		C	M	Y	K	
Acrylic Coated	Magnostar	7	2	1-2	4-5	ISO 4892-1
SBR Coated Gloss	Condat Gloss	6-7	3	3	4-5	ISO 4892-2
SBR Coated Gloss	Samarkand	6	6	4	4	ISO 105 B02
SBR Coated Matte	Condat Matte	6-7	2-3	3	4-5	ISO 4892-2
SBR Coated Matte	Perigord	6	6	4	4	ISO 105 B02
Uncoated	Hadar Top	6-7	5	3-4	3	ISO 105 B03
		Offset Ink				
		C	M	Y	K	
Acrylic coated		5	3	1	4	BS 1006B02
SBR Coated Gloss		6	2-3	1	4	BS 1006B02

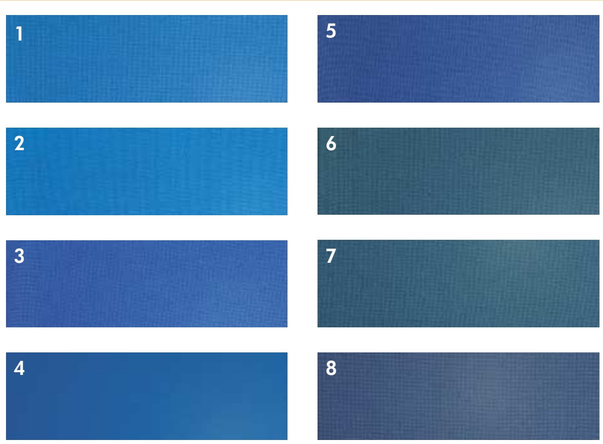
Please note that different paper brands and types may present deviations from the presented test results

Lightfastness test2: Changes in optical density and in color coordinates

This lightfastness test was performed according to a procedure specified by the Wilhelm Research Institute (www.wilhelm-research.com) by exposing test samples under an Atlas Suntest Tabletop Xenon Exposure System, for 3-day cycles while monitoring changes in optical density (%fading) and color coordinates (deltaE*). Each 3-day cycle simulates 6 years' exposure under the above conditions. 3 cycles of 6 days each, simulates 18 years. The tests were executed using HP ElectroInk technology (Liquid EP), Xerography technology (Dry EP) and Offset inks on various types of paper, intended to simulate a variety of typical substrates. (For a full list of papers used for all the tests described in these FAQs, please refer to page 10).

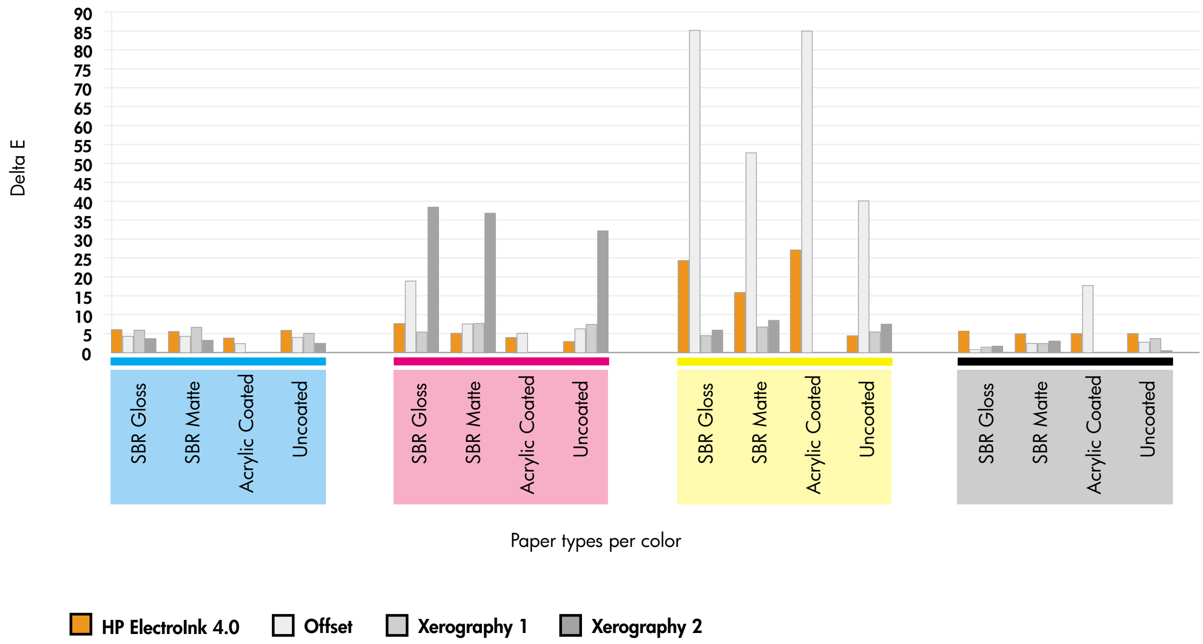
Blue Wool Scale [BWS]

Scale	Simulates number of days indoors before fading	Rating
1	3.75	Very poor
2	6	Poor
3	19	Fair
4	65	Moderate
5	130	Good
6	260	Very good
7	520	Excellent
8	1100	Outstanding

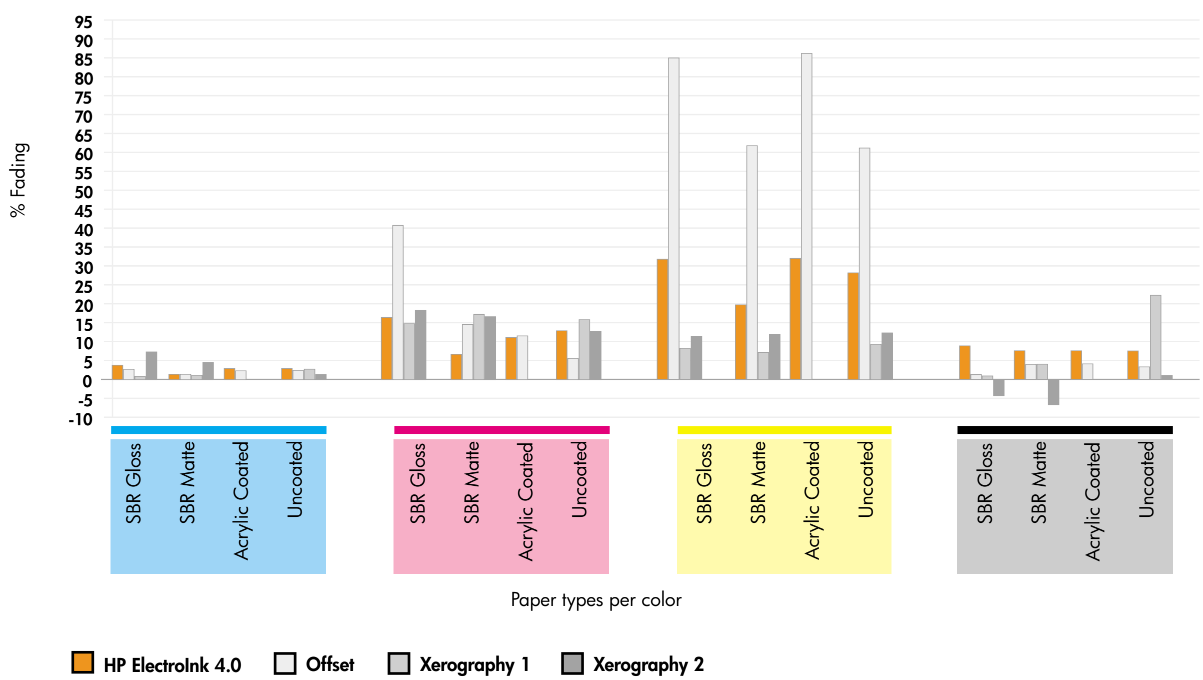


The Blue Wool Scale is composed of 8 strips of wool fabric, of different dyeing standards. Their chromatic grades range from 1, indicating very low lightfastness, to 8, indicating very elevated lightfastness. Each standard's value equals twice the solidity value of the preceding one.

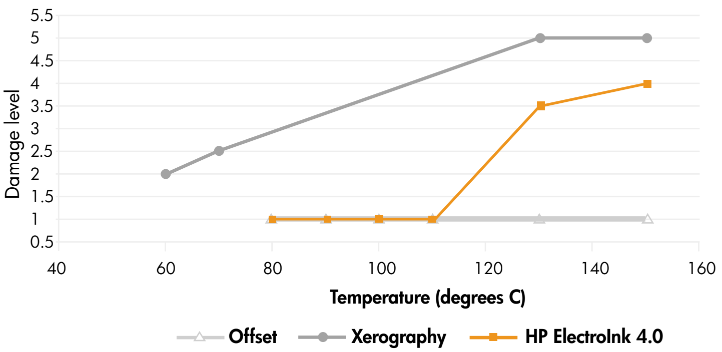
Lightfastness test results
Change in color coordinates at 6 days' exposure (12 years' equivalent)



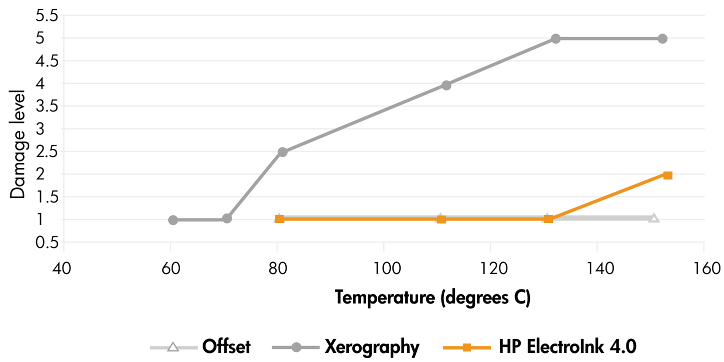
Change in in optical density at 6 days' exposure (12 years' equivalent)



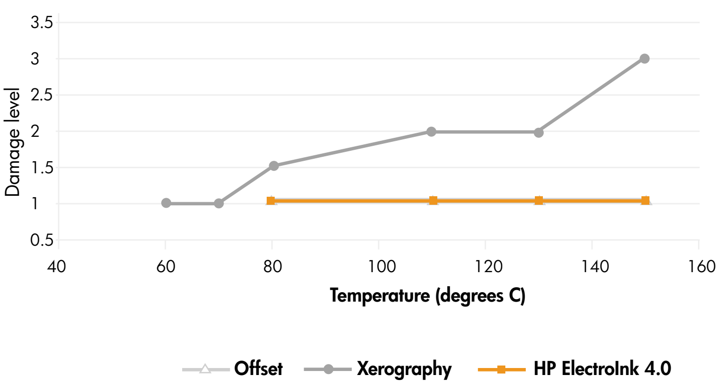
Heat resistance
SBR Coated Gloss 1 hour



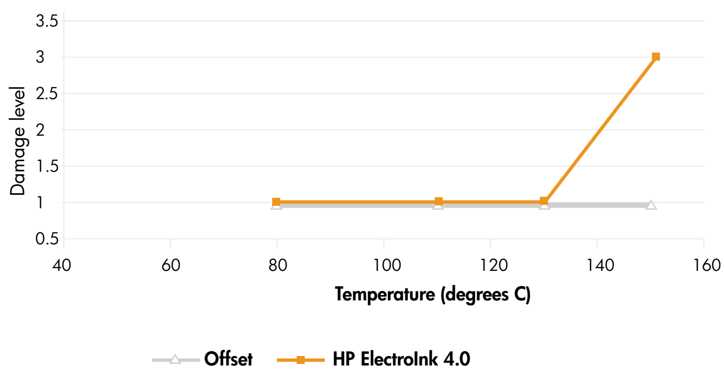
Heat resistance
SBR Coated Matte 1 hour



Uncoated 1 hour



Acrylic Coated Gloss 1 hour



How resistant to heat are HP ElectroInk prints?

The test for heat resistance measures the visible changes to print quality when 2 facing sheets, positioned so that the ink on one comes into contact with the ink on the other, are exposed to increasing temperatures (ranging from 60-150 degrees Celsius) under a steady pressure of 645 Pascal. The prints were tested after 1 hour's exposure and after 2 hours. The test is a qualitative analysis based on the examiner's visual evaluation of the degree of the damage ranging on a scale from "no damage" to "strong damage". The tests were executed using ElectroInk technology (Liquid EP), Xerography technology (Dry EP) and Offset inks on various types of paper, intended to simulate a variety of typical substrates. (For a full list of papers used for all the tests described in these FAQs please refer to page 10).

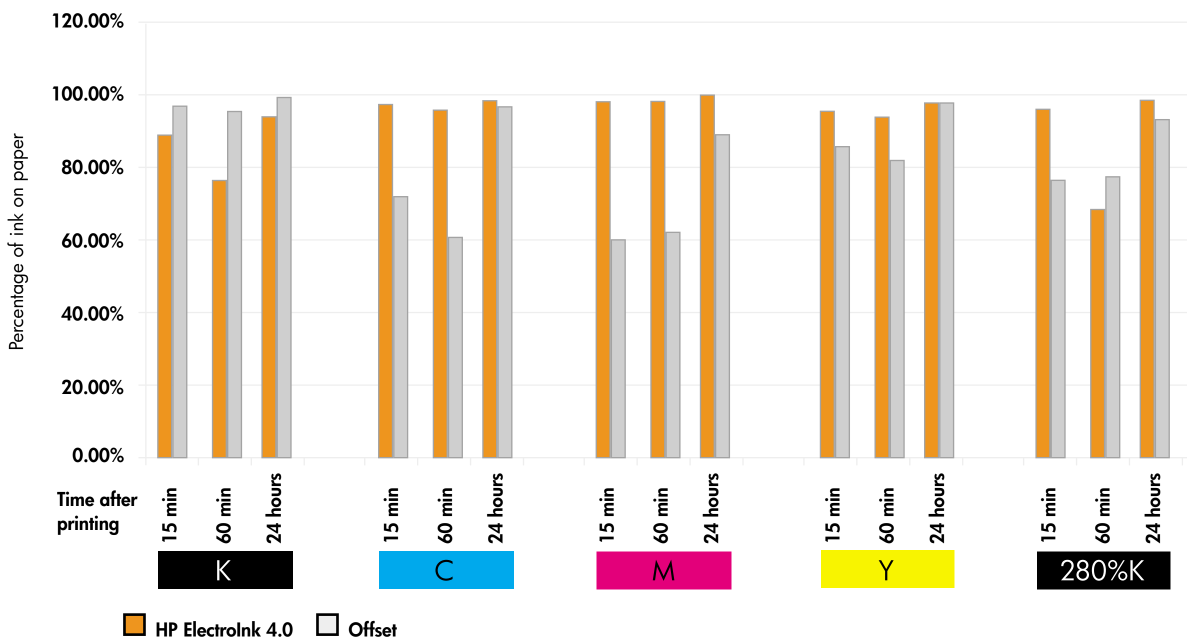
How well does HP ElectroInk adhere to paper?

HP ElectroInk's adhesion to paper is characterized by employing a test procedure that calculates the percentages of adhesion of solid colors to the paper surface using an image analysis system. Adhesion was measured after 15 minutes, 60 minutes and 24 hours from the time of printing, using a tape-pull procedure that applies a 3M® drafting tape #230 with a two pound roller weight.

The test for adhesion was performed by the Rochester Institute of Technology (www.rit.edu) under laboratory conditions as a simulation of on-site printing.

The tests were performed on two different types of substrates, simulating accepted types of coated gloss papers. Print samples were taken from the HP Indigo press using HP ElectroInk 4.0 as well as the Heidelberg QMDI. The measurements were taken at the 500, 1000 and 2000 printed sheet mark and evaluated on a pass-fail criterion, by color. (The results shown here are on a single type of paper at the 1000 printed sheet mark).

Adhesion to paper (SBR Coated Gloss,1000 printed pages)



May HP ElectroInk be used for printing food packaging applications?

Certain HP ElectroInk products, listed in the table on the right, are compliant with FDA requirements for printing on the non-food contact side of food packaging of an appropriate multi-layer food packaging material. The material used for the food packaging in conjunction with the approved HP ElectroInk must be comprised of one of the following materials: (1) low density polyethylene (LDPE) that is at least 40 microns thick; (2) polypropylene that is at least 20 microns thick; (3) polyester which is at least 12 microns thick. The resulting packages may be used to hold all types of food at temperatures up to 100 degrees C (also known as US FDA's Condition of Use B, “Boiling Water Sterilized“, under 21 CFR 176.170).[1]

The German and European food legislation (German Bundesinstitut für gesundheitlichen Verbraucherschutz und Veterinarmedizin (BgVV) and European Union (EU) is currently investigating the status of HP ElectroInk 4.0 and expect to have the data available by spring 2005. (Based however on previous versions of HP ElectroInk and on the FDA rating it is safe to state that HP ElectroInk 4.0 will also be approved for food packaging applications in the European Union under the conditions stated above).

IndiChrome	HP ElectroInk 4.0
Orange 070	Cyan 4.0
Violet 071	Magenta 4.0
Green 072	Yellow 4.0
	Black 4.0

[1]For FDA compliance of previous HP ElectroInk versions, see the previous HP ElectroInk FAQs white paper, on www.hp.com/go/graphicarts

Are any additional products recommended to enhance the adhesion of HP ElectroInk to the plastic substrates typically used in food packaging?

We recommend the use of a product called Topaz, which is distributed by HP Indigo, and is utilized in coating plastic substrates to enhance their compatibility with HP ElectroInk.

Can substrates treated with Topaz be used for printing on food-packaging applications?

In the U.S., substrates treated with Topaz can be used for printing on the non-food-contact-side of food packaging when they are composed of any of the following materials: (1) low-density polyethylene (LDPE) that is at least 40 microns thick; (2) polypropylene that is at least 20 microns thick; or (3) polyester which is at least 12 microns thick. The alcohol solvent evaporates after application, leaving a dry layer of Topaz. Material coated with Topaz on the non-food-contact side, can be employed in food packaging used to hold all types of food at temperatures up to 100 degrees C.

Use of Topaz also complies with the applicable provisions of German and European food legislation. (The German Bundesinstitut fur gesundheitlichen Verbraucherschutz und Veterinarmedizin (BgVV) and European Union (EU)). Substrates treated with Topaz can be used for printing on the non-food-contact-side of food packaging when they are composed of any of the following materials: (1) low-density polyethylene (LDPE) that is at least 40 microns thick; (2) polypropylene that is at least 20 microns thick; or (3) polyester which is at least 12 microns thick. The alcohol evaporates after application, leaving the Topaz as a dry layer. Material coated with Topaz on the non-food-contact side, can be employed as food packaging used to hold all types of food at temperatures up to 100 degrees C.

Do HP ElectroInk products contain any chemicals listed on California's Proposition 65 list?

HP ElectroInk 4.0 products do not contain any substance listed under the California Safe Drinking Water and Toxic Enforcement Act of 1986, (Proposition 65).

Do HP ElectroInk products contain any substances on the U.S. federal list of hazardous air pollutants?

As of August 1, 2002, none of HP Indigo's process ink colors (HP ElectroInk 4.0) or other supplies, contain substances that are listed on the United States federal list of hazardous air pollutants established under Section 112 of the Federal Clean Air Act. 42 U.S.C.A. §7412.



What is the concentration of heavy metals in HP ElectroInk?

Based on the formulation of our inks and information received from our suppliers, HP ElectroInk inks do not contain lead, cadmium, mercury and hexavalent chromium in a combined concentration exceeding 100 parts per million by weight of the ink in a dry state.

What is HP ElectroInk's flammability rating?

The solvent in HP ElectroInk has a flashpoint >64°C and is not restricted for any mode of international transport.

According to the Hazardous Materials Identification System (HMIS) and the National Fire Protection Association (NFPA) system, the flammability of HP Indigo HP ElectroInk, is rated at 2.

The HMIS hazard ratings are as follows:

- Minimal – 0
- Slight – 1
- Moderate – 2
- Serious – 3
- Severe – 4

For any specific workplace hazard warning and labeling requirements for these materials, please consult your local occupational health and safety regulations.

Is it true that HP papers printed with LEP inks cannot be recycled?

Media printed with LEP inks can be recycled and used for a variety of applications. HP, in conjunction with the Metafore's Paper Working Group and other research institutes, is researching new de-inking methods to ensure HP printed media can be recycled and re-purposed for a broader range of recycled paper products.

Initial experiments indicate that when some grades of commercial graphic arts media are used on the HP Indigo digital printing press, the resultant image film is difficult to separate from the recycled paper fibers using the traditional process. HP is presently investigating the extent of this problem and exploring possible modifications to the de-inking and printing process.

With which types of paper can HP ElectroInk 4.0 be used?

HP ElectroInk 4.0 can be printed on a wide variety of papers and non-papers including conveniently located off-the-shelf products. For specific types and brands in your area please refer to the Media Locator which can be found on the HP Indigo customer portal www.myhpindigo.com

Where can additional information about HP ElectroInk products be found?

Additional information relating to HP Indigo Imaging Products and Supplies, as well as material safety data sheets, can be found on the HP Indigo customer web portal under Supplies at www.hp.com/go/grapic-arts

Performance data presented in this document represent results obtained using specific press models, workflow versions, applications, media types and other variable testing components. Variations in performance may be expected when tests are carried out using different components. Users are therefore encouraged to perform their own tests under conditions typical of their own printing process.

Paper types utilized throughout this FAQ

Paper Type	Brand
Acrylic Coated	BVS
Acrylic Coated	Magnostar
SBR Coated Gloss	Condat Gloss
SBR Coated Gloss	Mirage Gloss
SBR Coated Gloss	Samarkand
SBR Coated Gloss	SAPPI 100# Lustro
SBR Coated Gloss	Silver Digital
SBR Coated Matte	Condat Matte
SBR Coated Matte	Perigord
SBR Coated Semi-Matte	Mirage Satin
Uncoated	Carnival
Uncoated	Eastern Inspire
Uncoated	Hadar Top

Glossary of terms

- **Abrasion:** The rubbing or wearing away of a material due to contact with another material. Dust is also a significant cause of abrasion.

- **Abrasion resistance:** The ability of materials to withstand the abrading action of the same or another material. The property is usually measured in terms of rate of loss of material by weight when abraded under specified conditions and length of time.

- **Adhesion:** A term indicating that two surfaces are held together by interfacial forces, which may consist of valence forces (chemical adhesion), interlocking action (mechanical adhesion), Van der Waals forces, or combinations thereof.

- **Color:** The multiple phenomena of light, manifest in the appearance of objects and light sources that are specified and described totally in terms of a viewer's perceptions pertaining to hue, lightness, and saturation for physical objects, and hue, brightness, and saturation for sources of light. The normal human eye is sensitive to a range of wavelengths from approximately 3.8/10,000 to 7.6/10,000 mm, with the longest wavelength being perceived as red, followed in descending order by orange, yellow, green, blue, indigo and violet. These are called Newton's spectral colors, i.e. they are seen when a beam of sunlight is split into its component parts, as it passes through a prism. Notwithstanding this separation, however, a precise limit for any single color cannot be made because the spectrum undergoes a continuous transition throughout the series. If the human eye perceives all seven kinds of light in the spectrum, and in the same proportions, the "color" seen is white.

  The color of a particular object is usually contingent on the white light striking the surface of the object and being completely or at least partially absorbed in the surface of the material, with the remaining light being reflected from it. Consequently, when a person sees the color red, for example, it means that all of the incoming wavelengths (white light) have been absorbed by the surface of the object viewed except those wavelengths which constitute the color we have designated as red. If the light reflected from the surface of the object is allowed to pass through a further colored layer before reaching the eye, such as, for example, a transparent yellow film, more light will be absorbed, and the result will be a mixed color, i.e. orange. This process is called "subtractive color mixture", or color obtained by successively eliminating light of different wavelengths from white

- **De-inking:** Paper recycling is comprised of a series of chemical/physical process steps used for papers that have gone through a variety of printing processes. In the first step, de-inking, the ink is removed from the surface of the media and then, in a series of additional steps, separated from the paper fibers.

- **Density:** In general, the ratio of the weight of a material to its volume, or the mass of the material per unit volume.

- **DEP:** Dry ElectroPhotography. The term used to describe dry toner based Xerography technologies.

- **Fadeometer:** An accelerated aging testing device which exposes samples of colored materials or coatings to a carbon arc to determine their resistance to fading. The arc emits an intense actinic light which in a matter of hours approximates the destructive effect of a much longer period of ordinary daylight. Although it does not exactly duplicate the effect of prolonged exposure to natural light, it is still an effective indicator of the degree of light stability that can be expected of a material, and of the comparative resistance to fading of a number of samples.

- **Fading:** The gradual loss of color of a pigment or dye that is chemically unstable. Unstable dyes or pigments become colorless (or at least less highly colored) compounds when they undergo chemical reactions upon exposure to the ultraviolet radiations of natural light, and to the oxygen, moisture, and other elements of the atmosphere. Dyes and pigments subject to these reactions are generally referred to as fugitive colors.

- **Gloss:** The surface characteristic of a material which enables it to reflect light specularly and which causes it to appear shiny or lustrous. Gloss is measured at various angles of illumination, and, although it is subjective in nature, it is clearly associated with the light reflecting properties of a surface.

- **Heat resistance:** The ability of materials to withstand excessive heat which may result in the lowering of flexibility, strength, and resistance to natural decay through loss of moisture, as well as acceleration of decomposition reactions.

- **LEP:** Liquid ElectroPhotography. The term used to describe HP's ElectroInk, and to differentiate it from other liquid toner technologies.

- **Rub-resistance:** The resistance offered by the coated or uncoated surface of a material to wear resulting from mechanical action on the surface of the material.

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Note
HP ElectroInk 4.0 is available only for the following HP Indigo presses: HP Indigo press 3000 (Indigo UltraStream), HP Indigo press 3050, HP Indigo press 5000, HP Indigo press w3200 (Indigo Publisher 4000) and for the HP Indigo press ws4000 (Indigo WebStream 100).

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08/2004

This is an HP Indigo digital print. Printed in Israel.

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