Tendency of Digitally Printed Materials to Ferrotype or Block

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Abstract

This study was undertaken to quantify the tendency of modern, digitally printed photographs and documents to adhere to each other or adjacent surfaces in storage. It has long been known that the gelatin binder used in traditional photographic prints can stick to glass in framing packages as well as to many types of plastic sheeting used in storage enclosures. This has typically been attributed to exposure of the materials to high humidity such as found in tropical climates. In this test, a variety of digital print types were incubated at 30°C and 90% RH for seven days and then visually assessed for adherence to polyester, polypropylene, and polyvinyl chloride films; envelope paper; typical framing glass; and both the face and reverse sides of prints of the same type. All digital prints tested were less likely to block or ferrotype than traditional color photographic prints.

Introduction

The purpose of this project was to determine if digitally printed photographs are as likely to block or ferrotype as traditional silver-halide photographs. Blocking is the phenomenon of prints adhering to each other front-to-back as in a stack or face-to-face as in a photo album, or adhering to adjacent smooth surfaces such as glass in frames or plastic sleeves in enclosures. Ferrotyping is similar to blocking, but instead of bonding between prints or to adjacent materials, the softening of the print surface causes the gloss of the print to be non-uniformly degraded.

It has long been known that the gelatin layer used in traditional photographic prints can bond to glass in framing packages and many types of plastic sheeting used in storage enclosures. It is assumed that the effect occurs when the glass transition temperature (which drops as humidity increases) of the print's gelatin layer is exceeded. Softening causes the gelatin to tightly conform to adjacent surfaces (such as framing glass or plastic enclosures). This can result in changes to the print's gloss locally or overall, or in extreme cases, complete bonding to the adjacent surface. Attempts to separate the print from the surface by force can result in peeling of the gelatin layer from the print or tearing of the print. It is important to note that ferrotyping and blocking can be avoided by maintaining proper storage conditions [1].

This paper is a major extension of previous work [2]. This project significantly expanded the number of test materials as well as the number of surfaces against which ferrotyping and blocking might occur.

Test Method

While there is a standard to evaluate blocking of photographic films [3], the authors know of no existing test method to evaluate the blocking or ferrotyping tendencies of traditionally or digitally printed reflection prints. Preliminary testing at IPI indicated that 30ºC (86ºF) at 90%RH can replicate the blocking effects often seen in consumer use for traditional photographic prints. These conditions are not designed for accelerated aging, but instead to emulate a worst-case scenario where a print may be stored, even briefly, in a hot, humid environment.

A total of 16 different unprinted papers were tested from the following groups: inkjet specialty photo (both porous and polymer), inkjet fine art, dye sublimation (printed to Dmin to include overcoat), chromogenic (processed to Dmin), and coated digital press. Several examples from each type were tested when possible.

A total of 10 different printed digital photographs were tested from the following groups: inkjet pigment, inkjet dye, dye sublimation, chromogenic, and digital press. The printed photograph samples consisted of uniform areas of sRGB 128, 128, 128 to create mid-tone, process gray. All of the inkjet samples were printed on the same paper (plain white office). This was done to ensure that the paper did not contribute to, and thus confound, the colorant test results. This was not possible for the dye sublimation and chromogenic, which were both printed with the manufacturer-recommended glossy papers. The digital press prints were created using coated glossy stock. Several examples of each type were tested when possible.

All samples were preconditioned to 21°C and 50% RH. Tests were performed in triplicate for both unprinted and printed samples.

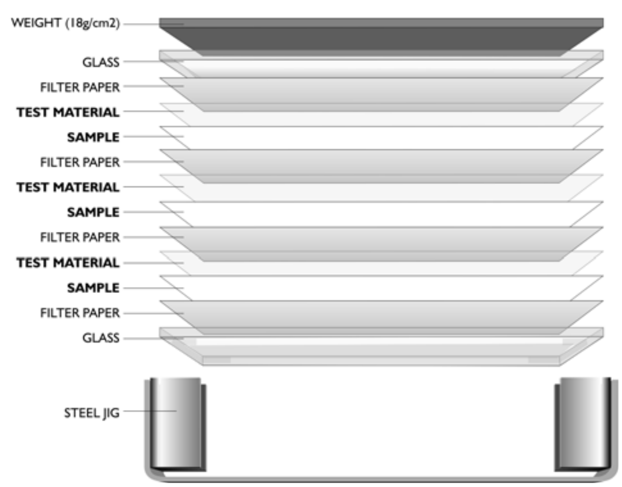

Figure 1. *Arrangement of test materials and digital print samples in test jig.*

The digital print materials were stacked into a specimen jig in the configuration shown in Figure 1. The materials were tested facing the following surfaces to evaluate their tendency to ferrotyping or blocking:

- Envelope paper (printed samples only)
- Polyester sheeting
- Polypropylene sheeting (unprinted papers only)
- Polyvinyl chloride sheeting
- Soda-lime framing glass
- Print back

- Print face

The weight on top of the stack was selected to represent the load on photos in an album on the bottom of a stack of albums. Nine filled photo albums were weighed and the load calculated to 18gr/cm2 (or 1.76 kPa) for the test's 2cm x 12cm samples.

The prepared jigs were placed in an ESPEC LHL-112 Humidity Cabinet incubation chamber on wire racks with sufficient space between them to allow for air circulation. Samples were incubated at 30ºC and 90% RH for seven days. At the end of the incubation period, the jigs were taken out of the oven and allowed to cool for 24 hours to room conditions (21ºC at 50% RH). The jigs were then disassembled and the samples visually evaluated for ferrotyping or blocking. In order to reduce operator-to-operator variability, a single observer examined all samples.

Results

Results for both the unprinted and printed samples were based on a four-level scale:

- No sticking, ferrotyping, or blocking
- Slight sticking but no surface damage or bonding
- Ferrotyping
- Blocking

Table 1 shows the level of ferrotyping or blocking for each of the unprinted paper types tested. Results are averages for the three replicates.

Table 1. Unprinted Photo Papers

Photo Papers	PET	PP	PVC	Glass	Print Face	Print Back	Overall Mean
Inkjet – fine art – porous	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inkjet – fine art – porous	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inkjet – fine art – porous	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inkjet – photo – porous	0.0	0.0	0.0	0.3	0.0	0.0	0.1
Inkjet – photo – porous	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inkjet – photo – polymer	0.0	1.0	1.0	0.3	2.0	1.0	0.9
Inkjet – photo – polymer	1.0	1.0	1.0	2.0	2.0	0.0	1.2
Inkjet – photo – polymer	0.0	0.0	0.0	0.7	2.0	1.0	0.6
Dye sublimation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dye sublimation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dye sublimation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromogenic AgX	1.0	1.0	1.0	3.0	3.0	1.0	1.7
Black-and-white AgX	1.0	0.7	1.0	0.7	1.0	1.0	0.9
Digital press – coated glossy	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Digital press – coated matte	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Digital press – uncoated text	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overall Mean	0.2	0.2	0.3	0.4	0.6	0.3	

It is apparent that the gelatin-coated silver-halide papers (black-and-white AgX and chromogenic AgX) were the most sensitive to ferrotyping and blocking. These materials were damaged in the same manner as those examples of ferrotyping and blocking found in existing consumer collections. It can be concluded that all of the digital technologies are less sensitive to ferrotyping and blocking than traditional photographs. The only other materials to ferrotype or block were the polymer-coated inkjet papers. Their coating, like traditional photo coating, is designed to swell with increasing moisture content.

Table 2 shows the tendency to ferrotype or block by test surface. Prints are most sensitive to damage when stored face-to-face. This too matches what has been encountered in practical applications. The data belie the fact that some printing technologies were impervious to this problem, so blanket statements suggesting that digital prints should never be stored face-to-face would be inaccurate.

Table 2: Blocking/Ferrotyping by Surface

Surface	Mean
PET	0.2
PP	0.2
PVC	0.3
Glass	0.4
Print front	0.6
Print back	0.3

Clearly, some materials were completely insensitive to ferrotyping and blocking (see Table 1). Recommendations for print usage and storage should be made by imaging material and not by the surface with which it may come in contact. For instance, it appears that porous-coated inkjet prints could be framed directly against glass, as there appears to be little chance of their bonding over time.

Table 3: Printed Photo Papers

Photo Printer/Paper	ENV	PET	PVC	Glass	Print Front	Print Back	Overall Mean
Inkjet pigment – porous	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inkjet pigment – porous	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inkjet dye – porous	0.0	0.0	1.0	0.0	0.0	0.0	0.2
Inkjet dye – polymer	0.0	1.0	1.0	1.0	1.0	0.0	0.7
Dye sublimation	0.0	0.0	1.0	0.0	0.0	0.0	0.2
Dye sublimation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromogenic AgX	0.0	2.0	2.0	3.0	3.0	0.0	1.7
Digital press - liquid toner	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Digital press - dry toner	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Digital press - dry toner	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overall Mean	0.0	0.3	0.5	0.4	0.4	0.0	

The data for the printed papers show the same trends as for the unprinted papers, indicating that the colorants neither add to nor detract from a technology's propensity to ferrotype or block.

Envelope paper was included to test the potential for the colorants to transfer under these conditions. None of the samples showed colorant transfer. The lack of colorant transfer between materials seen in the test should not be taken to mean that color transfer is not an issue. It is possible that the conditions used here to evaluate the ferrotyping and blocking tendencies of digital prints were not severe enough in either temperature or duration to produce colorant transfer.

Table 4 shows the tendency of printed images to ferrotype or block by test surface. In this case the results were different for the printed samples. Here, PVC was most likely to ferrotype or block to the surfaces of prints. PVC is already considered unacceptable for storage of photographic images, and that recommendation can now clearly be extended to digital prints. However, the data again belie the fact that some printing technologies were impervious to this problem, so the recommendation that digital prints should never be stored using PVC may be questionable. Over time, however, PVC can exude plasticizer, which may also be damaging. This demonstrates that resistance to ferrotyping and blocking should not be the only criteria used for selecting materials to store or display digital prints. Other criteria can be found in *ISO 18902-2007 Imaging materials—Processed imaging materials—Albums, framing, and storage materials* [4].

Table 4: Blocking/Ferrotyping by Surface

Surface	Mean
Envelope paper	0.0
PET	0.3
PVC	0.5
Glass	0.4
Print front	0.4
Print back	0.0

To further examine the blocking tendencies of digital prints, a variety of photobooks were incubated under the same conditions used for the individual print tests described above (see Table 5). The same rating scale was used for the photobooks as for the individual prints.

Table 5: Photobooks

Photobook	Damage
Digital press - liquid toner	0
Digital press - dry toner	0
Digital press - dry toner	0
Chromogenic - matte	1
Chromogenic - glossy	3

The results of the photobook incubation matched the results of the individual print tests. Prints made on the digital presses produced no ferrotyping or blocking. Matte chromogenic exhibited minor damage. Glossy chromogenic pages bonded when face-to-face, but showed no damage when face-to-back.

Conclusions

In general, the following conclusions can be reached:

- When exposed to high humidity, digital prints are less likely to block or ferrotype than traditional silver-halide photographs.
- All prints are least likely to block when stored front-to-back (as in stacks) or against envelope paper.
- Sensitive prints are at highest risk for blocking and ferrotyping when they are stored face-to-face as in a photo album or photobook.
- Photobooks made from silver-halide photographs or polymer-coated inkjet prints may block or ferrotype if they are assembled with prints face-to-face.
- In photobooks, matte papers sustained less damage than glossy papers after exposure to high humidity.

References

[1] ISO 18920-2000 Imaging Materials—Processed Photographic Reflection Prints—Storage Practices (International Organization for Standardization, Geneva, Switzerland, 2000).

[2] D. M. Burge, A. Venosa, G. Salesin, P. Adelstein, and J. Reilly, Beyond Lightfastness: Some Neglected Issues in Permanence of Digital Hardcopy, Proc. Intl. Symposium on Technologies for Digital Fulfillment, pg. 61 (2007).

[3] ISO 18901-2002 Imaging Materials—Processed Silver Gelatin Type Black-and-White Films – Specifications for Stability (International Organization for Standardization, Geneva, Switzerland, 2000).

[4] ISO 18902-2007 Imaging Materials—Processed Imaging Materials—Albums, Framing, and Storage Materials (International Organization for Standardization, Geneva, Switzerland, 2007).

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