

Heat Tolerance Testing

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I have been researching mounting and handling images for the picture framer since my affiliation with Seal Products back in the 80's. During the 90's, Seal researched new products and developed specialized presses to accommodate wide format prints for the commercial digital market as we picture framers remained comfortable in our world of lithographs, RC photos, and open edition reproductions. Then came giclées, digitals were born into custom framing, and the rest is history.

Initial Electrophotographic Heat Testing

With the launch of four-color copiers, picture framers first began noticing heat sensitivities of thermographic processes. Faxes turned black, colors often changed, and



Photo 1: Test Samples—All digitals were mounted in a Seal 210M-X mechanical press for one minute at temperatures ranging from 150°F to 220°F. Samples represented include all common digital technologies that might be suitable for framing.

surface gloss was damaged when items were placed in heat presses.

In 1996, after pursuing Seal Products, Xerox, and Kodak about how to best mount and handle these color copies (electrophotography), I was commissioned by Seal to do the test, establish heat tolerances for mounting and laminating these printed images, and come up with a basic set of user guidelines. The results of this year-long test

may be found in "Color Copies Parts I and II: From Lightfastness to Laminates," (*PFM*, March and April 1997), as well as in *The Mounting And Laminating Handbook* (pgs. 60, 102, 138-139).

Little did I realize that, years later, the dawn of digitals would send me off on yet another quest. But before reporting the results of the digital heat tolerance testing from 2001, the concepts of thermography should be explained a little to help lay the groundwork and fill in any blanks.

Thermographic Printing

In printing, thermography (meaning "heated printing") is a raised-letter printing process that simulates engraved printing by applying a fusible powder to an oily, slow-drying wet ink prior to drying. The sheet is then passed under a heater

As digital art becomes commonplace and consumers increasingly display this media, it's important for framers to be educated about it. Knowing how to identify, handle, house, and store these works of art enables you to assist your customer in deciding how to frame their items. In this six-part, bimonthly series, "Digital Directions," *PFM* has invited several writers in the industry to discuss the topics related to this subject today.

to fuse the ink and powder. Some inks contain an expansion agent that, when exposed to heat, creates a raised letter effect.

When first tested back in the 80's, inexpensive business cards, stationery, and wedding invitations with raised plastic thermographic lettering used to melt, flattening out into illegible blobs of ink if exposed to prolonged heat and pressure. Therefore cold mounting methods (wet, spray, or pressure-sensitive applications) were suggested. In recent spot testing this past year I have found many of these materials currently hold up under heat. I suppose that means new technology has improved their tolerances.

Thermographic Photocopying

In thermographic photocopying (or "writing with heat"), an original document and sheet of special copy paper are passed together through a machine that exposes them to heat, or infrared rays. The ink used on the original must contain a metallic or carbon compound in order to absorb the infrared radiation. The copy paper contains a heat-sensitive substance fused between a transparent sheet of paper and a white, waxy backing. The original heats the darkened areas of print and transfers the image to the copy sheet. These must be cold mounted.

Thermal or Non-Impact Printers

Impact printers and dot matrix printers use an inked ribbon to

apply, via pressure, an image onto a sheet of plain paper. Non-impact printers require thermal or electrostatic transfers of the original image rather than mechanical means. (See last month's "Mastering Mounting" for a more in-depth explanation of non-impact printers found under the digital umbrella. Some are heat-sensitive, some are not as seen later in this article.)



Photo 2: Test Strips—Images were divided into sections that were subjected to timed heat exposures, so comparisons could be made within the context of all temperatures on one tested image.

Facsimiles (Faxes)

Derived from the Latin "fac simile" (made like), this term refers to a process of reproducing graphic material from a distance. A light-sensitive device scans the image to produce an electric signal that is sent over telephone lines. Reproduction of the received copy can be on photographic, electric-sensitive, or thermal (heat-sensitive) paper.

Any fax produced from heat will continue to darken when further exposed to any heat source. Warmth from the sun, a mounting press, or even heat inside a frame may activate the paper thus darkening whites and blackening grays. Cold mounting is required for these

images. Plain paper faxes do not have the same technology producing the image and are safe to dry mount with heat.

Mounting Questions

The ongoing questions surrounding dry mounting of digitals and thermographic heat-sensitive items have been addressed for years by suggesting cold mounting alternatives.

With the above thermographics the application of moisture in wet and spray adhesives has not routinely impacted them, but with today's digitals the water solubility of many inks prohibit some of the wetter mounting methods.

I have often stated if you do not know the origin of an image do not dry mount it. Sounds as though you cannot wet or spray mount it either, making pressure-sensitive the only mounting alternative. It should come

as no surprise that pressure-sensitive applications are the mounting of choice for most commercial digital and large format users.

Heat Tolerance Testing

In my attempt to resolve the mounting dilemma of digitals, I needed to conduct an in-depth study about their tolerances. With the onset of digital photographs that look remarkably like color RC photos, it seems necessary to find a mounting method besides preservation techniques and pressure-sensitive materials that might be safe for these hybrid images.

Dry mounting is the desired method for digitals. It is fast,

permanent, and involves no moisture. However in some instances, mounting temperatures can damage or melt the inks depending upon their printer technology. So in July 2001, I took it upon myself to seriously look into the heat tolerances of digitals. Last month in "Mastering Mounting," I wrote about the family tree of digital images and identified their technical workings. To date I have concluded two parts of this fact-finding test—printer technologies and digital photos. I also expect these results may require constant refurbishing to keep up with the evolution of digital technology. What is true today may not be true tomorrow.

The Players

The first part of the test identifies common printers and their technology (see Photo 1). Although I had done the 1996 testing on copiers, new copier technology needed to be retested in this format. Printer samples in the test are as follows:

- Dry toner electrophotographic printers included Minolta CF900 and Canon 360PS.
- Electrostatic toner copiers included Xerox 2135 and 2006, Scitex Spontane, Kodak ColorEdge, and IBM 3170.
- Laser printers included: Xerox N Series; DocuColor Phaser 2006; and Tektronix 550, 750, and 790.
- Thermal transfer printers included Kodak Digital Printer, Tektronix 240 (on film), and 440.
- Inkjet thermal printers included

the bubblejet technology of HPdeskjet 960c on both paper and photo paper, Tektronix 140, and Digital Painter (on canvas).

—Inkjet phase change technology using a solid wax stick or puck that melts to be sprayed, included Tektronix 340 and 860.



Photo 3: Melted Image—The left hand piece is a segment of the single-sided release paper used in the heat test of this Tektronix 240 thermal transfer image onto film. Notice the inks have melted and transferred to the release paper (left) under the 170°F temperature also severely damaging the original (right).

Hypothesis

It has been known for a long time that dry mounting is the most long-term, permanent mounting method (aside from preservation applications) available to framers. It is also the most time- and cost-effective method. A truly low temperature mounting adhesive might be the answer. The test was completed to establish low-end heat tolerances for the above technologies. This would better determine whether or not very low-end heat mounting adhesives currently available in the custom framing market could compete with pressure-sensitive mounting for use with digitals.

Since the release of the low

temperature, heat-activated (HA) product called SpeedMount™ from Nielsen Bainbridge, there has been the possibility of mounting digital images within a heat press. Since digital images are often fused under heated rollers at temperatures much higher than the 150°F/66°C mounting temperature offered by this particular product, it could be an answer to safely dry mounting previously heat-sensitive items. However, this theory needed to be tested.

Controls

All digitals were subjected to temperatures of 150°F (66°C), 170°F (77°C), 185°F (85°C), and 200°F (93°C). Heat tests were conducted in a Seal 210M-X Mechanical press, and the images were placed under the clamped platen using single-sided release paper for a period of one minute at each temperature (see Photo 2). All tests were exactly the same. The test was performed twice to help verify the results.

The fast time/low temperature was selected specifically because of SpeedMount, which mounts in at 150°F in 15 seconds. Other temperatures were chosen to match current industry dry mounting tissues. Because of the lack of substrate, one minute was an adequate time for the mounting package to reach total bonding temperature. Currently 170°F bonds low-end, removable tissues and 185°F is considered the industry average for permanent tissues. The 200°F is the upper-end, adhesive film tem-

Printer	Type	1 minute @	150°F	170°F	185°F	200°F	225°F laminate
Minolta CF900	Magnetic roller, dry pigment toner	yes	no	no	no	no	no
Xerox 2135	Color single pass LED	yes	no	no	no	no	50/50
Xerox 2006	Single pass LED	yes	yes	50/50 light colors only	50/50	50/50	50/50
Canon 360PS	Electrophotography, dry toner	yes	50/50	50/50	50/50	50/50	no ink clots
Scitex Spontane	Electrostatic toner copier	yes	no	no	no	no	no ink clots
Kodak ColorEdge	Electrostatic toner copier	yes	no	no	no	no	no ink clots
IBM 3170	Single pass LED	yes	no	no	no	no	no
Xerox N Series	Black and White Laser	yes	yes	yes	yes	yes	yes
HPdeskjet 960c	Inkjet on paper	yes	yes	yes	yes	yes	yes
HPdeskjet 960c	Inkjet on photograph paper	no	no	no	no	no	no
Kodak Digital Printer	Thermal transfer aka: Dye sublimation, dye diffusion, dye transfer	yes	yes	yes	yes	yes	yes
Tektronix Phaser 140	Liquid inkjet	yes	yes	yes	yes	yes	yes
Tektronix Phaser 240	Thermal transfer on film	yes	no melted	no	no	no	no
Tektronix Phaser 340	Phase change, solid ink	yes	no melted	no	no	no	no
Tektronix Phaser 440	Thermal transfer, dye sublimation	yes	50/50	no	no	no	no
Tektronix Phaser 550	Color laser	yes	yes	50/50	no	no	no
Tektronix Phaser 750	Color laser	yes	no	no	no	no	no
Tektronix Phaser 790	Color laser	yes	yes	50/50	50/50	50/50	yes
Tektronix Phaser 860	Phase change, solid ink	yes	transfers to release paper, soaks through image			yes	yes
DocuColor Phaser 2006	Color laser	yes	yes	no	no	no	yes
Digital Painter	Inkjet on Canvas	yes	yes	yes	yes	yes	N/A

Diagram 1: Results show that when dry mounted at the lowest temperature of 150°F all but one of the digitals were undamaged and acceptable for mounting. The only image damaged at that low temperature was the inkjet HPdeskjet 960c on photo paper. It showed major gloss damage, which is beyond the range of tolerable surface damage. ("Heat Tolerance Testing: Part Two," using digital photos, will further research these types of bubblejet images on assorted digital and inkjet photo papers.)

perature not likely to be used with digital mounting; however it provided an upper-end mounting contrast.

Results at 150°F

Test results were surprising in some cases. All digitals (with the exception of the inkjet on photographic paper) passed the heat mounting test at the lowest temperature of 150°F. There were two images printed with an HPdeskjet 960c inkjet printer. One was on absorbent porous paper, which withstood the temperature as all the others had, while one was printed on non-absorbent, non-porous photo paper, which was dam-

aged at the low temperature. The damage resembled the scuffing damage that silicone does to high gloss RC photos which is totally unacceptable for framing.

What surprised me was that phase change images (that are melted waxy ink sticks converted into a spray) actually tolerated these low temperatures. These phase change inks will melt when subjected to heat, so even with the positive results of this test, it is suggested to keep these images away from the heat.

Results at 170°F

As mentioned earlier, the selected test temperatures and times were

chosen to match currently available low temperature tissue products. At 20 degrees higher, the resulting damage was inconsistent and a visible problem. Electrophotographic prints were both good and bad, electrostatic images were more damaged at this temperature than not, and laser image results were also both acceptable and not acceptable.

I have been told that thermal transfers are heat-sensitive, yet the Kodak photo quality, dye sublimation print I used did not melt at 150°F or 170°F as had been expected. However, the thermal transfer Tektronix 440 dye sublimation printer did transfer a ghost image at

170°F, while the thermal transfer on film melted altogether (see Photo 3).

Results at 185°F to 220°F

By studying Diagram 1 it is safe to say that if an image is visually damaged at 170°F it will not improve at higher temperatures. The few laser, inkjet, and one thermal transfer Kodak dye sublimation image that withstood the 170°F now needed to be checked at the higher average temperatures of 185°F to 220°F. At these higher temperatures a few of the laser images did not pass the test, but the inkjet bubblejet technology still passed. The dry toner electrophotography images now began to show the removal of the glossed surface and the results were visually 50/50. Some images began to ghost onto the release paper; when this happens it will transfer to the surface of the next unsuspecting project.

The Chart

The results are recorded on the chart as to positive tolerance or not (see Diagram 1). If an item is listed as "Yes," it passes the visual requirements for a quality end product that would meet customer needs without damaging or threatening the digital image. If listed as "No," it was impacted by the heat and pressure combination and the viable alternative would be a pressure-sensitive board, or non-invasive conservation hinging.

Some results were marginal so when a "50/50" is listed, it is a visual judgement call of the professional as to whether the mounting should be allowed. These 50/50

images show a slight hint of visual change but still rather subtle. These were also better on lighter-colored images and more visibly damaged on darker surfaces. At no time was lightfastness, monetary, or sentimental value, nor preservation noted, meaning that though a signed, numbered, limited edition giclée may tolerate the heat of a mounting process, it should still never be subjected to dry, wet, spray, or pressure-sensitive mounting.

Recommendations

I feel that at 150°F (66°C) a standard custom picture framer will be able to heat mount many digital items previously damaged by the higher required heats. The chart illustrates the dramatic results—all but one of the digitals being safe at 150°F and only slightly damaged at the higher 170°F. It remains to be seen whether different papers will react to temperatures differently based on the absorption or not. A desktop inkjet printer such as the HPdeskjet 960c will be safely mounted and laminated at all temperatures ranging from 150° to 220°F, but the same inks on a Kodak Professional Picture Paper for digital photographs is damaged at as low as 150°F.

It appears that there will always be a risk when attempting to mount any digital with heat, even the low 150°F, but the risks may be low enough and the digitals easy enough to replace for the framer to take the mounting risk. SpeedMount could be an answer to current digital heat mounting needs, but it still remains a judge-

ment call and the risks exist. Perhaps dry mounting should only be attempted when additional image copies are in reserve.

Laminates

The final test involved applying a narrow strip of non-perforated vinyl heat seal laminating film across the top edge which was then covered with sponge overlay and placed into a 220°F (104°C) press for a full five minutes to laminate. The reason behind testing a high temperature laminate with these digitals is that although an image may be heat-sensitive and not approved for dry mounting at lower 170-185°F temperatures, the laminated result may be visually acceptable.

The damage that occurs at mounting temperatures is often the removal of the even gloss that occurs during the setting of inks or toner between heated fuser rollers during its printing. This partial removal of gloss may be camouflaged during the coating of a laminate over the image. But damage can also occur to inks when laminating.

When it has been indicated a digital image does not tolerate laminating, it may not be the temperature but rather the mounting adhesive of the laminate that impacts the resulting lamination. The binders used in the mounting process of some pigment inks are sensitive to the adhesive used to bond the laminate. When heated to laminating temperature they appear to release, float around, and reclump prior to setting. The resulting image appears clumped making fine type fuzzy or difficult

to read, and solid color areas very pointillistic like a Seurat painting.

Though a few of the inkjet and dye sublimation images looked good in this test, the results showed that lamination is still not advisable on digital images.

In Closing

I am currently working on the American National Standards Institute (ANSI) committee for the standardization of heat- and pressure-sensitive products for manufacturers as well as a document of suggested techniques for application. When they are complete, we hope to submit these documents to the International Standards Organization (ISO) for their acceptance and approval.

In my next article for "Digital Directions," I will address the

second part of my testing. With the results of the current test, the biggest question is over the varied results of the inkjet on plain paper versus photo paper. Would all brands of non-absorbent photo paper on the same HPdeskjet 960c react the same when mounted? It appears that digital photos are in a whole different world than either RC photos or digital images on plain paper. As mentioned previously, I will provide these results when I gather them. ■

My heat tolerance testing as discussed in this column, and the next one to be reported, as well as my affiliation with the ANSI committee has generously been sponsored during 2001 by Nielsen Bainbridge.