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Investigation of Fusion 4000 as an Alternative to Lascaux for Hinging Inkjet Prints

Alice Cannon

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Joint Meeting in Wellington, New Zealand.*

Abstract

Lascaux 360HV and 498HV are commonly used adhesives in photographic conservation. Both adhesives, either singly or in mixtures, have been used successfully for hinging and repairing a variety of photographic formats. The solvent and heat-activation properties of Lascaux adhesives are attractive, particularly for mounting oversized and contemporary photographic works.

However, recent tests at the Canadian Conservation Institute (CCI) found that both Lascaux adhesives failed the Photographic Activity Test (PAT). The PAT has been used as a standard in the conservation field for establishing what materials can be safely used in conjunction with traditional photographic formats.

Though a recent study by the Image Permanence Institute suggests the PAT cannot be used to accurately predict the effects of materials on inkjet photographic images, it seems wise to investigate alternatives to Lascaux. To this end, Fusion 4000 dry mounting adhesive was investigated for the purpose of mounting a large contemporary work by photographer John Gollings.

Fusion 4000 is an ethylene vinyl acetate (EVA) film used for face mounting photographs. It passed the PAT in CCI's testing and is activated by temperatures of 77-82°C. Using the clip peel test method, it was determined that Fusion 4000 is weaker than Lascaux 498HV in peel strength, though in shear mode both adhesives are very strong. Peel test results for Fusion 4000 were similar for both Japanese paper and Hollytex™ hinges. Designed to be used in a heated press, the success of the adhesive bond depended greatly on consistent application of heat and pressure, much more so than Lascaux. However, Fusion 4000 appears strong enough to be used in many instances, particularly as many hinging methods utilise shear forces. The clip peel test, used primarily by textiles conservators to date, proved to be a useful aid to decision-making.

Introduction

This paper outlines research and testing performed prior to mounting a large format inkjet photograph. It had been planned to carry out a standard strip-lining technique, as described by Morrison (2007). However, recent research by the Canadian Conservation Institute (CCI) found that the adhesive of choice — Lascaux 498HV — was unsuitable for use with photographic works, as it had failed the Photographic Activity Test (Down et al 2011). Therefore, testing was carried out to identify another adhesive that could be used in a similar manner to Lascaux. This involved identifying an alternative adhesive, based on CCI's adhesive testing program, constructing mock-ups of the hinging method, and conducting peel strength tests to objectively judge the strength of the replacement adhesive when compared to Lascaux 498HV.

The Work

The work to be mounted and framed was an untitled photograph by Melbourne architectural photographer John Gollings. Gollings is known for his technique of photographing at night, using partial artificial light over an extended exposure time. The photograph shows the State Library of Victoria and was scheduled to be included in an exhibition called *The Enchanted Dome*. This exhibition opened in late 2012, as part of the State Library's celebratory programs for the 100th year of the library's domed reading room.

The photograph measured approximately 1120 x 1840 mm. It was printed on 300 gsm Epson Traditional Photo Paper (known in the US as Exhibition Fibre Paper — see Wilhelm 2010), using pigment Ultrachrome inks. Gollings' studio uses an Epson Stylus Pro 11880 printer to print his works in-house, and the work was printed on this machine in February 2012.

The Problem

Mounting large contemporary photographs is not a routine task at the State Library of Victoria, though more and more such works are being added to the collection. In the past we have used mounting techniques developed by other organisations, such as the National Gallery of Victoria. These generally have involved attaching hinges along all edges of the verso of the photograph and stretching them taut around a rigid support. This allows the photograph to be displayed in a box frame, without a window mount. A variety of hinging materials and adhesives has been used.

We were keen to do something similar for the Gollings photograph and looked at using the strip lining technique method described by Morrison (2007). Morrison's technique utilises hinges of about 20cm in width, which are applied to the entire perimeter of the reverse of a photograph. The hinges are generally made from Hollytex and are secured with a one-centimetre wide strip of Lascaux adhesive, heat-set. Once applied, the hinges are then wrapped around a rigid support like Dibond (an aluminium and polyethylene laminate) and secured with Velcro. This method allows the photograph to be retensioned if necessary. This method has been used extensively and successfully for several years.¹

Our general approach was therefore clear. However, in 2011 a study (Down et al) by the Canadian Conservation Institute (CCI) found that both commonly used varieties of Lascaux failed the Photographic Activity Test (PAT). This begged the question — should we still use Lascaux? If not, what alternative could we use? Tests on sample pieces of the Epson photographic paper showed that starch paste could not be used for hinging — though it adhered well, it altered the surface of the front of the work, causing distortion and a change in gloss. We wondered what other adhesives might be suitable for this purpose.

Lascaux

Lascaux 360 HV and 498 HV, manufactured by Lascaux Restauro, are water-soluble acrylic dispersions. The acrylic polymer is made from methyl methacrylate (MMA) and n-butyl acrylate (BA), thickened by acrylic butylester. They are manufactured to have a pH of 8-9 and are "biocide stabilised". The manufacturer's safety data sheet (MSDS) for each product notes that they contain 1-5% ammonia solution (Lascaux 2004 a & b). The 1999 product information sheet

notes that the base dispersions are also available as Plextol D-360 and D-498, without a thickening agent (Lascaux 1999).

Dried films of both adhesives can be activated by solvents or heat. The 360 HV requires a minimum sealing temperature of about 50°C; the 498 HV requires about 68-76°C.

Lascaux 360 dries to a very elastic, permanently tacky film. Lascaux 498 HV dries to a stronger film.

The 2011 CCI Photograph Activity Test (PAT) found that both types of Lascaux failed the part of the PAT that tests for oxidation and reduction of the colloidal silver. There are three components to the PAT; Lascaux failed the oxidation and reduction test but passed the mottling and staining measurements (Down 2012).

We sent samples of our own Lascaux to the National Archives of Australia (NAA), who are an accredited testing facility. We sent samples from two different batches of each adhesive — one dating from 2005/2006 and the other dating from 2012 (this being the date we received the adhesives, not necessarily the year in which they were manufactured). The NAA found that the older samples passed the PAT but the newer samples failed, again failing the image test for oxidation and reduction. They concluded that either something had off-gassed from the older samples or that there had been a formulation change. They recommended that each new batch of Lascaux be tested (Rai 2012).

The Photographic Activity Test

The Photographic Activity Test (PAT) was developed by the Image Permanence Institute to evaluate materials used for the storage and display of traditional photographic materials. The PAT incubates a sandwich consisting of two types of detectors and the material to be tested (e.g. an adhesive) in order to predict the long-term interactions between the test material and photographs. It can be used to predict the long-term effects on inkjet, electrophotography and dye sublimation prints, as well as traditional silver-based photographic processes. The PAT cannot be used to assess the effects on some other color processes, like diazo prints.

A paper published recently by staff at the Image Permanence Institute (Gordeladze et al 2011) did find that the PAT results for adhesives were not always valid for digitally printed materials, but this was because adhesives reacted with digital materials in ways that the PAT is not designed to detect — for example, bleeding of inkjet colors due to water-based adhesives, physical distortion of the support, or staining not detected by the gelatin stain portion of the PAT. They concluded that the PAT does not accurately predict all interactions between adhesives and digital prints and that there is need for further investigation of the long-term effects of adhesives on inkjet materials.

However, seeing as the Gollings photo was an inkjet print and thus the results of the PAT are thought to be applicable, we thought it prudent to investigate alternatives to Lascaux.

Fusion 4000

The 2011 CCI study included hinges made using Fusion 4000, an ethylene vinyl acetate (EVA) film used to face-mount contemporary photographs onto rigid supports. It is applied using a heat press, which heats the adhesive to about 80°C and then allows it to cool while remaining under pressure. This latter step is an important part of achieving a good bond (D&K Group 2005). Fusion 4000 passed the PAT in the CCI study (Down et al 2011).

We conducted experiments to determine if Fusion 4000 would work using the hinge method described by Morrison (2007). We prepared the hinges in a similar manner, using strips of Fusion 4000 film cut one centimetre thick ironed onto Hollytex hinges. The tacking iron was set at 85°C. The resulting hinges were not satisfactory and could be peeled away from the photographic paper test pieces very easily.

However, we also set up a mock hinge, attaching a hinge to a sample piece of Dibond and hanging a small weight from the hinge by using a bulldog clip and cotton tape. After several days the hinge was still solid.

These subjective judgments didn't feel like a good way to make decisions. Fortunately, Karsten (2005, 2011) developed a method of using clip peel tests to make more objective assessments of the strength of adhesive bonds. This method has been used primarily by textiles conservators, to assess the strength of adhesive bonds for lining fragile textiles. Karsten found that by making a series of weights and attaching them to samples of bonded materials, a lab method could be used that closely fitted the results obtained from more scientific equipment.

Strength Testing - Method

Karsten's method relies on the use of six different weights, made using fabric or Tyvek and metal shot. The six weights are 10 g, 25 g, 50 g, 75 g, 100 g and 150 g. These weights correspond to bond strengths ranging from very weak to very strong, when measured with an analytical machine such as an Instron Universal Testing Instrument. Test hinge samples (comprised of the substrate, adhesive and hinge material) are cut to 25 mm widths. (This also allows adhesives across various studies to be compared more easily). The sample strips are attached to a retort stand using a bulldog clip, and the "peel" of the test materials is started by hand. Then a test weight is attached to the bottom of the hinge, again using a bulldog clip (included in the overall weight measurement), starting with the smallest (10 g). The weight at which the bond fails is recorded. Karsten recommends testing the bond at multiple points, as the peel strength of a bond can vary from point to point; we tested each sample at three points within the bonded area.

Failure of a 25 mm-wide specimen to hold a 10 g weight indicates a very weak bond. The ability to hold a 150 g weight indicates a very strong bond — and, in Karsten's work, a bond too strong for most textiles conservation purposes. In photographic conservation we have not made any such formal or quantitative decisions regarding adhesive strength, beyond a certain degree of practical working knowledge — i.e. an adhesive that is too weak will not remain stuck; an adhesive that is too strong may cause curvature, distortion or make adjacent areas more susceptible to failure or tearing.

Samples were prepared using Lascaux 498, as per Morrison's method (undiluted film painted onto silicon release, dried and cut into one cm and two cm strips, applied with a tacking iron), and with Fusion 4000 (one cm and two cm strips, applied with a tacking iron and later with a lining iron). I also tested the Fusion 4000 with both Hollytex 3257 and kozo paper hinges. All hinges were applied to offcuts of the Epson paper used to print the photograph; these offcuts were supplied by Gollings' studio.

Strength Testing - Results

The Lascaux hinges passed all the clip peel tests (see Table 1). According to Karsten, Lascaux used in this manner (undiluted) would classify as a very strong adhesive.

In comparison, the Fusion 4000 hinges we made using the tacking iron sometimes failed even the 10 g test, making them very weak. The results were not consistent, however, suggesting that the quality of the bond was very variable. We decided this was due to inconsistencies and inadequacies in our production method — mainly, that not enough heat was applied for long enough. In fact, the two cm thick hinges performed worse than the one cm strips, probably because overall less time and heat was spent per unit area of adhesive in their manufacture.

So we rethought our manufacturing method. Fusion 4000 is usually used in a heat press, with even and prolonged heat exposure and pressure. A cool-down period is also advised. Using a tacking iron inevitably results in inconsistent temperature and pressure application. Instead we tried a heavy lining iron made for paintings conservation, thereby providing the necessary pressure. We set it to 85°C, though it was more often at about 90°C. After a heating period of 30 seconds we allowed the hinge to cool down under a glass weight, again for at least 30 seconds.

The Fusion hinges made using this second method passed all tests up to the 100 g weight, failing the 150 g test. This makes it a moderately strong adhesive. The samples made using two cm strips of Fusion 4000 passed the 150 g test as well. This demonstrated very effectively that the hinges we made in this way were much more consistent in quality than those we made using the tacking iron. It was probably also faster, and easier on our hands. So, the clip peel tests also assisted us to develop a better, more reliable way of making the hinges, one that more closely resembled the way Fusion 4000 is used in a heat press.

Fusion 4000 was tested with hinges made from Hollytex and a kozo Japanese paper, mostly just to see if there was a difference in bond strength; both hinge materials returned the same results. The paper hinges were nicer to work with, as it was easier to handle and the Hollytex had a tendency to wrinkle under the heat. But the paper hinges weren't as robust or abrasion-resistant when it came to retensioning the hinges with Velcro, over the relatively sharp edge of a piece of Dibond.

Table 1: Results of peel tests, where P = pass and F = fail

Adhesive	Hinge	Application method	Temp. (°C)	Length of heat application (seconds)	10g	25g	50g	75g	100g	150g
Lascaux, 1cm	Hollytex	Tacking iron	80	10	P	P	P	P	P	P
Lascaux, 2cm	Hollytex	Tacking iron	80	10	P	P	P	P	P	P
Fusion 4000, 1cm	Hollytex	Tacking iron	90	10	P	P	F	P	F	F
Fusion 4000, 2cm	Hollytex	Tacking iron	90	10	F	F	F	F	F	F
Fusion 4000, 1cm	Kozo	Tacking iron	90	10	P	P	F	P	F	F
Fusion 4000, 2cm	Hollytex	Lining iron	85-90	30 (+ cool down)	P	P	P	P	P	P
Fusion 4000, 2cm	Kozo	Lining iron	85-90	30 (+ cool down)	P	P	P	P	P	P
Fusion 4000, 1cm	Hollytex	Lining iron	85-90	30 (+ cool down)	P	P	P	P	P	F
Fusion 4000, 1cm	Kozo	Lining iron	85-90	30 (+ cool down)	P	P	P	P	P	F

Mounting the Photograph

Though Lascaux was undeniably stronger than the Fusion 4000 and less susceptible to variations in application, we decided to try the Fusion 4000, as the test results suggested it was strong enough. We made the hinges according to the method described previously (using the lining iron) and applied them to the reverse of the photograph using the same application and cooling methods. (Testing had been conducted to make sure the photographic paper wouldn't be affected by the heat and weight of the lining iron). I decided not to use the two cm wide Fusion strips as I thought perhaps I could see a little distortion of the paper on a larger mock-up, around the adhered section, when compared to the one cm strip. Once the hinges were applied, a piece of Dibond was laid over the verso of the photograph and the hinges stretched around and attached to the Dibond using low-profile Velcro. The photograph was then placed into a box frame for display.

Conclusions

At the time of writing this paper, the photograph has been on display for about ten months. The hinges appear sound and there is no evidence of slippage or failure. This single case study isn't conclusive evidence that Fusion 4000 is acceptable to use in this manner for long periods, of course, but it shows strong promise as a mounting adhesive. The clip peel test method developed by Karsten was very useful in helping us to make a decision about what mounting adhesive to use, and could prove very useful to photographic conservators in general — especially as it doesn't require any expensive analytical equipment. It is likely that photograph conservators

could benefit from examining the work done by textiles conservators in this area more closely. Karsten and her colleagues (2005, 2011) have examined many factors influencing bond strength — adhesive concentration, activation method (heat or solvent), the type of substrate and so on — and this may help photographic conservators to formulate more appropriate mounting and lining methods. It may also be beneficial for us to consider what the ideal strength of an adhesive for various purposes actually is and to consider how we can better make use of the differences between shear and peel modes. There is certainly much more research that can be done.

Endnotes

1. It should be noted that Morrison reviewed and reassessed this method at the 2013 AIC & ICOM-CC Photographs Conservation Joint Meeting in Wellington, New Zealand. Mounted photographs were often not flat enough for the artist's liking and required laborious retensioning. The National Gallery of Victoria is leaning more and more towards fully mounting photographs to their supports, rather than using a strip lining technique.

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Sources of materials

- *Dibond*: White/Metallic sheet 2500 x 1000 x 2 mm, cut to size and supplied by Alucobond Architectural (alucobond.com.au).
- *Fusion 4000 Dry Mounting Adhesive*: manufactured by Expression Framing Products, a division of D & K Group, Inc. (dkgroup.com, forframersonly.com), supplied by Talas (talasonline.com) via Archival Survival (archivalsurvival.com.au).
- *Hollytex*: #3257 (thickness 0.00029”), manufactured by Ahlstrom Filtration LLC®, supplied by Talas (talasonline.com) via Archival Survival (archivalsurvival.com.au).
- *Japanese paper*: Yachio, thick, No. 1266 (kozo, machine-made) from Masumi Corporation (masumi-j.com/english/profile.html, info@masumi-j.com)
- *Lascaux 498HV*: manufactured by Alois K. Diethelm AG, Lascaux Farbenfabrik (lascaux.ch), supplied by Talas (talasonline.com) via Archival Survival (archivalsurvival.com.au).
- *Lining iron*: Model C”01 RH Conservation Engineering (<http://www.rhconservationeng.com>)
- *Velcro*: 3M Dual Lock Low Profile (SJ4570), supplied by Adept Industrial Solutions (adept-industrial.com.au).

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