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Characterizing Resin Coated Surfaces and Evaluation of Adhesive Systems to Hinge-Mount for Photographs and Digital Prints

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The display of resin coated (RC) photographs and digital prints on RC type papers are increasingly commonplace at The Museum of Modern Art. Notable examples include the recent acquisition of Fluxus works which includes more than 3,000 photographs, many identified as RC prints, contemporary color photographs and archival materials which are growing in demand for exhibition. The acquisition and display of these prints is now well established in museums that collect and exhibit contemporary art; however there remains a need for their safe and effective mounting.

This material presents certain challenges because they often require secure contact to a limited area of a surface that has a weak affinity for adhesives. MoMA is currently investigating a selection of adhesives and attachment systems for the display of early RC photographs and assessing new RC papers contemporary photographers are using.

RC papers were developed in the early 1960's and are now ubiquitous in photography and digital imaging supports. When they were first introduced, RC photographs had a variety of flaws affecting the long term preservation of the different components. Today however, this paper type has fewer defects and has become widespread, particularly with the development of RC type papers for digital printing.

The raw materials can also be found in prints and drawing papers. The optical properties of RC paper and its dimensional stability under high humidity are qualities that contribute to the paper's popularity.

The polyethylene coating on the verso of the RC paper is what makes hinging difficult. Chemically, polyethylene is a nonpolar wax-like substance and on balance most adhesives have more of an affinity for themselves than for non-polar surfaces. Thus, in this instance an adhesive's *cohesion* wins out over its propensity to *adhere*. When photographs are overmatted for presentation, they are easily set into mats with photo-corners avoiding altogether the need for an adhesive: this is the preferred preservation standard at MoMA. On the other hand, when a photograph needs to be "floated" in the window mat or presentation frame, invisible "v" hinges or some other system must be employed. Large unmounted photographs present further complications and are often attached to rigid supports with a modified strip lining when traditional hinges are deemed insufficient. There can be additional aesthetic factors which must be considered and each photograph is evaluated on a case-by-case basis.

This investigation set out to characterize a range of RC type papers and identify an adhesive or hinge-adhesive system that could be safely used to adhere to an RC layer without affecting the long-term preservation of the photograph. We centered our investigation and evaluation of materials on four critera:

Reliable Workability

Workability of a hinge depends on the physical and chemical properties of an adhesive and its related application requirements. Conservator's skills and familiarity may influence procedure outcomes. It has not been a priority in this research to develop a system so easy to use that an untrained conservator could use it successfully.

Strong Enough

Flat and V-hinges are, respectively, shear and peel mode of testing. The capacity of a hinge to support a load is influenced by the adhesive and the carrier selected. The paper-adhesive bond does not have to be exceedingly strong ; theoretically just strong enough to support the paper weight but two or three times the paper weight for safe design might be acceptable while 20 to 30 times the weight is over-engineering to the detriment of reversibility.

Reversibility

Reversibility is considered good when the hinge readily peels off with no alterations to the paper using a light force applied in a direction different from the distribution of forces when the work is mounted. An adhesive bond that is too strong will be proportionally that much more difficult to reverse without risk to altering the planarity of the paper. Effort was made to rank the negative aspects associated with difficult to reverse systems (Table 1) and when planer deformations, skinning, burnishing or stubborn adhesive residues result a material properties score, or ranking, is correspondently low.

Table 1. Hinging Test Scores

Adhesive's classification	Adhesive	Carrier	Shear Strength	Peel Strength	Reversability	PAT	ODDY
Cast Adhesive	AQUAZOL 500 35% film / hollytex	hollytex	4	0.5	4	P	F
Cast Adhesive	AQUAZOL 500 35% film / paper	paper	4	4	4	P	F
Cast Adhesive	AQUAZOL 500 35% H2O / hollytex	hollytex	4	0.5	4	P	F
Cast Adhesive	AQUAZOL 500 35% H2O / paper	paper	4	0.5	4	P	F
Cast Adhesive	BEVA D8 / T 85C / hollytex	hollytex	4	0.5	4	F	F
Cast Adhesive	BEVA D8 / T 85C / paper	paper	4	0.5	4	F	F
Cast Adhesive	JADE 403 / hollytex	hollytex	4	0.5	2	F	F
Cast Adhesive	JADE 403 / paper	paper	4	1	2	F	F
Cast Adhesive	JADE R / hollytex	hollytex	4	0.5	2	F	F
Cast Adhesive	JADE R / paper	paper	4	1	4	F	F
Cast Adhesive	KLUCEL G 8% Ethanol / hollytex	hollytex	4	1	4	P	F
Cast Adhesive	KLUCEL G 8% Ethanol / paper	paper	4	0.5	4	P	F
Cast Adhesive	KLUCEL G 8% film / hollytex	hollytex	4	0.5	4	P	F
Cast Adhesive	KLUCEL G 8% film / paper	paper	4	1	3	P	F
Cast Adhesive	LASCAUX 303 HV / hollytex	hollytex	0	0.5	2	F	P
Cast Adhesive	LASCAUX 303 HV / paper	paper	4	2	2	F	P
Cast Adhesive	LASCAUX 498 HV 75C / hollytex	hollytex	4	1	2	F	F
Cast Adhesive	LASCAUX 498 HV 75C / paper	paper	4	1	2	F	F
Cast Adhesive	MC MC4 / hollytex	hollytex	4	0.5	4	P	T
Cast Adhesive	MC MC4 / paper	paper	4	1	4	P	T
Cast Adhesive	MOUSSE GELATIN 5% / hollytex	hollytex	4	0	1	P	T
Cast Adhesive	MOUSSE GELATIN 5% / paper	paper	4	1	2	P	T
Cast Adhesive	WHEAT STARCH PASTE / hollytex	hollytex	4	0.5	2	P	T
Cast Adhesive	WHEAT STARCH PASTE / paper	paper	4	1	3	P	T
Film Adhesive	BEVA film 371*/T 70C / paper	paper	4	2	2	P	F
Film Adhesive	BEVA film 371*/T 70C / hollytex	hollytex	4	3	2	P	F
Film Adhesive	BEVA-TEX 66C / Beva carrier	beva carrier	4	1	2	P	N.A.
Film Adhesive	GUDY 870 / paper	paper	4	2	2	P	P
Film Adhesive	GUDY 870 / hollytex	hollytex	4	0	2	P	P
Tape	3M SCOTCH 001 / taper carrier	Tape carrier	4	1	3	F	T
Tape	3M SCOTCH 002 / tape carrier	Tape carrier	4	0	4	P	N.A.
Tape	3M SCOTCH 889 / paper	paper	4	0.5	4	P	N.A.
Tape	3M SCOTCH 889 / hollytex	hollytex	4	0	4	P	N.A.
Tape	GUDY Dots / paper	paper	0	0	3	P	N.A.
Tape	GUDY Dots / hollytex	hollytex	0	0	3	P	N.A.
Tape	TYVEK TAPE	Tape carrier	4	2	2	P	P

Table 1. P: Pass; T: Only for short-term us; F: Fail; N.A.: Not available.
This graph combines shear, peel and reversibility results after nine months. The carrier plays a pivotal role in the hinge's effectiveness. See the difference in peel strength when a paper or polyester carrier are employed. **Shear**: 0 = fail / 4 = pass **Peel**: 0 = fail / 4 = still holding at 270 days. *Note: Beva 371 tested was the original (Laropal K80) formulation.

Non-reactive with image material and PE
AIC-Wiki Material database was consulted (http://www.conservation-wiki.com/wiki/Materials_Testing) and Photographic Activity Test and Oddy Test were conducted on the most promising untested adhesives. Arrhenius studies are currently being carried out at Wilhelm Imaging Research Inc. to assess longevity.

The first stage was the characterization of resin-coated surfaces. This characterization considered 8 name-brand RC papers that are currently available in the US and one historic paper by Kodak, circa 1978. ATR-FTIR data was collected from the verso using both diamond and germanium crystals to sample the coating at different depths. ATR results indicate the papers vary in polarity ranging from highly olefinic (wax like) to oxidized (polar) surfaces. The extent of surface oxidation was measured according to the carbonyl band in the region 1725-1730 cm^{-1}. It is thought the oxidation is primarily designed to improve ink adherence but will also facilitate adhesion in general and will beneficially impact the strength of the hinge's bond. Results indicate the historic paper is coated with unmodified polyethylene (i.e. no carbonyl present) while the modern papers range from the same non-polar polyethylene resin to more polar surfaces. Similarly, in-situ contact angle tests were developed to assess the paper's surface polarity of the verso and potentially inform adhesive selection.

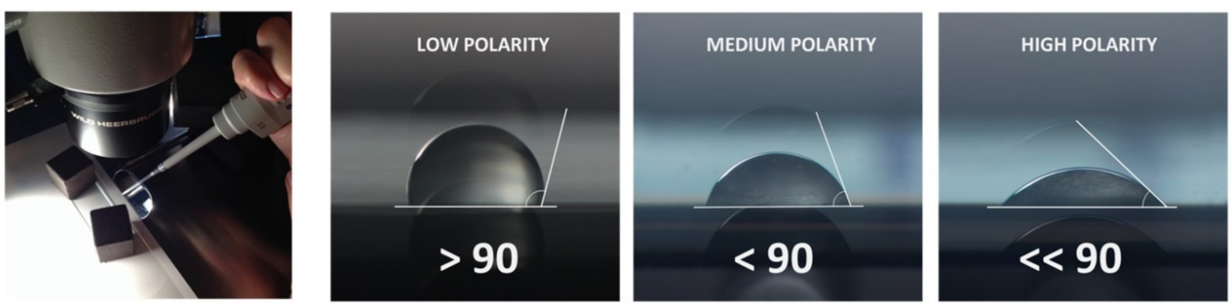

Figure 1: (Left to right) **A**: in-situ contact angle setup using a microscope, adjustable mechanics mirror, 100 microliter pipette. Images B-D are mirror reflections captured through the microscope. **B**: contact angle of Ilford Multigrade, pearl; ca. 1978 Vintage Kodak Chromogenic, Ilford Galerie Prestige Gold, Kodak Polycontrast Rapid RC paper; **C**: Fuji Crystal Archive, Canon Photo Plus Glossy, ca. 1978 Vintage Kodak Chromogenic, Hahnemühle Photo Pearl 310, Epson Signature Luster; **D**: Ilford Galerie Prestige Metallic, Hahnemühle Photo Luster, Hahnemühle Photo Glossy, Canon Platinum PT-101.

Interestingly, we found that for versos that wet a surface well had the strongest carbonyl band of the group of papers tested (group D in Figure 1) while those that did not wet out onto the verso had very low or no detectable carbonyl at all (group B in Figure 1). The same vintage Kodak paper gave results that ranged between group B and C. That variability may be due to surface contamination or the effects of uneven oxidation from aging. The results suggest this simple test is a useful way to test whether or not it is necessary to tailor an adhesive specifically for what is thought to be an intrinsic property of RC surfaces.

Tapes were studied for shear and peel strength using conditions that approximate the load of the largest prints that might be exhibited. Nine adhesives and nine films or tapes form the core set of materials in this study. These materials were configured onto two medium weight carriers (non-woven polyester, hollytex, and Japanese paper) under a variety of application techniques for a total of 36 samples, each replicated four times. Results presented here include hands-on workability evaluation, photographic activity test (PAT) findings, silver sensitivity (sodium azide test), and two 9-month natural aging studies of hinges under realistic but high loading. The shear mode findings were good for most of the adhesives tested, including wheat starch paste and methyl cellulose, but in peel mode - the Achilles' heel for thermoplastic adhesives - tapes failed more rapidly or show signs of creep. This suggests that if the latter mode can be avoided in the hinge design, adhesives that are more easily reversible on demand could be utilized for any of the papers tested. A summary of the results are presented in the table 1.

Future reports on this research will include findings from optical methods, mainly micro RTI and light-section microscopy of the verso and FTIR studies.

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