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PHOTO ENCLOSURES RESEARCH AND SPECIFICATIONS

by

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Enclosures (encompassing sleeves, envelopes, folders, boxes and file cabinets), as well as inks and adhesives, are an important aspect of the microenvironment of photographic materials in storage. This presentation will review the possibilities for harmful chemical and physical interactions between processed photographs and their storage and display materials. Relevant ANSI Standards will be discussed, together with practical recommendations for archivists in selecting photographic enclosure materials. The newly-adopted ANSI Photographic Activity Test, an accelerated aging test developed at the Image Permanence Institute, will be described and examples of its use presented.

HARMFUL EFFECTS OF STORAGE ENCLOSURES

The role of storage enclosures in directly causing deterioration of photographic materials has long been underestimated. Beginning in the 1840's, photographers seeking to understand the various causes of print fading tended to give greater notice to problems whose onset was rapid and whose symptoms were obvious and acute. Thus it was that residual hypo came to be regarded as the most important cause of print fading, when in reality image oxidation was the most serious overall problem. Image oxidation can be caused by either atmospheric pollutants or by enclosures. The latter is the subject of this paper. It was recognized in the 1850's by Hardwich (1) and others that improper mounting adhesives can cause fading. But at this early date, difficulties from papers and mount boards were not recognized, because most such products were of reasonable quality at that time, and because of the long, slow time scale on which such harmful effects are manifested.

The introduction of highly lignified wood pulp boards and papers in the later 19th century proved to be a significant factor in deterioration of silver images. Two examples which stand out as especially important are the envelopes and original sales boxes used to store gelatin dry plates, and the mounts and album constructions used with print materials. Both these are instances where close contact with impure papers has resulted in innumerable cases of deterioration. The symptoms typically seen are overall fading, highlight detail loss, silver mirroring, and discoloration of image silver from black to yellowish-brown -- indeed, all the common manifestations of oxidative attack on black and white photographs. Often contact with such highly lignified materials results in staining of non-image areas.

Glue seams are frequently areas of particularly severe attack. It should also be noted that harmful interactions can occur both by direct contact or through the vapor phase.

It is difficult to determine either in general or in any specific case just how much contribution to deterioration has been made by inappropriate enclosures. Many of the same symptoms can be caused by other sources of oxidative attack. The life of a photograph in storage is very long and subject to many influences -- general environmental conditions always act together with the aspects of the microclimate contributed by enclosure materials. Moreover, there has not been a long history of using accelerated tests to measure the effects of enclosures on photographs, so it is easy to understand why their role in deterioration has been under-rated. Perhaps the most significant boost to awareness of enclosure quality came in the 1960's when inferior cardboard storage cartons were shown to contribute to the formation of "redox blemishes" on microfilm (2). More recent evidence, some of which is presented in this paper, suggests that the harmful effects of enclosures can be quite severe. The problem for contemporary archival managers is how to select storage enclosures which are safe, functional, and cost-effective.

ENCLOSURE STANDARDS

Since the 1950's, an American National Standards Institute (ANSI) Standard has existed which covers specifications for photographic storage materials. The current standard is ANSI PH1.53-1986, "Processed Films, Plates, and Papers -- Filing Enclosures and Containers for Storage." (This standard is under revision and will be re-issued as ANSI IT9.2 before the end of 1988; it will be referred to hereafter in this paper as IT9.2.) Among the general requirements are that all enclosures should be free of acids, peroxides, reducible sulfur, and that the surface should neither be too rough (to scratch) or too smooth (to cause sticking or ferrotyping). All should be chemically stable, and every enclosure must pass an accelerated aging test known as the "Photographic Activity Test (P.A.T.)." This test attempts to empirically determine whether there will be chemical interaction between a photograph and its enclosure over its storage lifetime.

ANSI IT9.2 represents the best thinking of the photographic industry, enclosure manufacturers, government agencies, and consumers on the question of enclosure quality. Suitable plastics for enclosure use include uncoated polyester (polyethylene terephthalate), polyethylene, and polypropylene. Chlorinated sheeting such as polyvinyl chloride (PVC) and nitrated plastics are prohibited. Paper for use with black-and-white photographs should contain at least 87% alpha cellulose, and have an alkaline reserve of at least 2% molar equivalent of calcium carbonate, with a pH between 7.2 and 9.5. For use with color photographs, the alkaline reserve requirement does not

apply, and the pH should be between 7.0 and 7.5. Any printing inks used should not bleed or transfer, nor affect the image of the photograph.

Apart from these guidelines, the main assurance of inertness offered by ANSI IT9.2 to archival consumers comes from the Photographic Activity Test. Prior to 1988, the P.A.T. procedure allowed for varying types of photographs to be utilized as the "detector" of harmful influences. For example, if microfilm enclosures were under consideration, then samples of processed microfilm were to be used in the test. Incubation conditions were 30 days at 50 Deg C, 86% RH. The ANSI Subcommittee recognized that this method had serious shortcomings (it lacked sensitivity, depending on the detector chosen) and in 1983 requested that IPI undertake more research to improve the test. With funding from the National Museum Act, the National Endowment for the Humanities, and the National Historical Publications and Records Commission, nearly five years of research at the Image Permanence Institute has resulted in a greatly improved test procedure.

ENCLOSURES RESEARCH AT THE IMAGE PERMANENCE INSTITUTE

The most important feature of the improved Photographic Activity Test is the use of two standardized "detectors" for harmful chemical interactions. One detector measures the tendency of enclosures to react with silver images and cause fading. The other measures the tendency of the enclosure to stain gelatin. These two detectors are incubated in contact with the material to be tested; at the same time, a control enclosure of known purity is also incubated with similar detectors. After the test period is over, the amount of overall fading, staining, and mottling (uneven, blotchy fading) caused in the detectors by the enclosure is compared with that observed in the control. Quantitative measurement of fading and staining is obtained by making blue filter reflection and transmission density measurements before and after incubation, and then calculating density changes. Pass/fail criteria for fading and staining are based on these measured density changes, while mottling is evaluated by visual inspection of the fade detector samples.

Detector of Image Fading

The fading detector used in the improved P.A.T. consists of very small, round particles of silver dispersed in a gelatin layer coated on polyester film base. Such coatings have been referred to as "Carey Lea silver" (after the 19th-century scientist who first described their properties), or simply as "colloidal silver." The use of colloidal silver coatings of this type to evaluate impure storage atmospheres and enclosures was first suggested by Edith Weyde of Agfa in 1972 (3), though no practical details of how to evaluate enclosures were offered.

The essential features of these coatings which make them suitable for the P.A.T. are the small particle size and the fact that they are on an impermeable support, so that impurities migrating from the enclosure remain concentrated in the emulsion layer. Colloidal silver coatings are considerably more sensitive to harmful chemical interactions than many other types of silver photographic images (4), and therefore are ideally suited to be detectors in the P.A.T.

Detector of Staining Tendency

Staining reactions between enclosures and gelatin are significant in practice. The improved P.A.T. utilizes a premium-grade fiber-base photographic print material as the detector of stains caused by enclosures. The photographic paper is prepared for use in the test by fixing and archivally washing (without exposure or development), so that it contains no silver image whatever. Any yellow staining that occurs during incubation as a result of contact with the enclosure can therefore be ascribed to interaction with gelatin, not silver. The essential features of a photographic print paper for use as a stain detector in the P.A.T. are a relatively thick baryta layer and thick emulsion layer. There are several brands of "premium" grade papers on the market which may be successfully used.

The Test Procedure

Readers are directed to ANSI IT9.2 for a detailed account of the test procedure and evaluation criteria. Incubation is carried out at 70 Deg C, 86% RH for 15 days. Either a temperature humidity chamber or a desiccator jar containing a saturated solution of barium chloride may be used to attain the test conditions. Alternating strips 2 X 12 cm of detectors and enclosures are built up in a "sandwich" under a total pressure of 5 g/cm2. The control enclosure is Whatman #1 laboratory filter paper. In developing the test method and pass/fail criteria, the Image Permanence Institute performed over 360 trials of enclosure materials. With the cooperation of the National Archives and other collections, enclosures which had actually caused problems in real world storage were used to "benchmark" the test results. Several 1930's folders and a microfilm box which apparently caused "redox blemishes" were among the known harmful materials employed. On the other hand, uncoated photographic support from Eastman Kodak Co., Whatman chromatography paper and various 100% rag papers of known pure composition were used to define acceptable performance.

The pass/fail criteria are as follows: 1) There shall be no readily visible mottling of the colloidal silver fading detector strips. 2) The mean fading (calculated as initial minus final density) of the enclosure being tested shall not be greater than that of the controls plus a small "error factor

allowance" (which was established at twice the measured standard deviation of the controls). 3) The staining criterion are that the enclosure shall not cause a mean density gain in the staining detector any larger than that of the controls plus 0.05 blue reflection density units. Here, too, an error factor allowance is provided. This 0.05 density units allowance was based on subjective visual judgments of stain acceptability, measurement error, and the behavior of known acceptable products.

PRACTICAL APPLICATION OF THE NEW PHOTOGRAPHIC ACTIVITY TEST

To illustrate the use of the P.A.T. method in the selection of enclosures for use in archival collections, an experiment was performed in which 90 different enclosures were evaluated. This included 66 commercially available materials which could be considered "archival," not by any strict scientific definition, but because they were sold by suppliers specializing in this line of products. The 66 archival materials included 36 rag boards, 9 non-rag boards, and 21 papers, numbering among them interleaving tissues, Japanese repair tissues, barrier papers, envelope papers, glassines, and slip sheets. These materials were obtained from a number of manufacturers and distributors and are representative of the kinds of products that might be used in archival collections in contact with photographs. Also included were a number of known good and bad "benchmark" materials to put the performance of the archival products in perspective.

The outcome of the test for the 66 archival products is given in Table 1. This table shows how many of the products failed in each of the three pass/fail criteria. Overall, 29 (44%) of the archival products passed the P.A.T. The most common cause of products failing the P.A.T. was mottling (uneven blotchy fading of the colloidal silver detector). Most of these failed products were 2 or 4 ply boards. In all, 25 products (38%) failed the mottling criterion. Mottling represents the presence of local "hot spots" of fading and generally indicates inhomogeneity in an enclosure product.

Figure 1 shows a frequency histogram of the performance of the 66 archival products in the fading criterion. The horizontal axis values are the mean fading of the products relative to the filter paper controls. The positive values on the horizontal axis indicate less fading than the controls, while the negative values indicate more fading than the controls. The tallest bar of the histogram occurs near 0.00, meaning that most products caused about the same amount of fading as the controls. Note that the distribution of fade data is approximately normal, and that a number of products caused significantly less fading than the controls. This is apparently because some products contain substances which have a reducing effect on silver ions; we do not fully understand this behavior, and do not use it as a basis for rejection, but we feel it is

generally undesirable in a photographic enclosure. Often products which fade much less than the controls also demonstrate a propensity for heavy staining. Overall, 16 (24%) of the archival products failed the fading criterion.

Figure 2 shows a frequency histogram of stain data for the 66 archival products. The horizontal axis values are the measured stain relative to the filter paper controls. None of the products stained less than the controls, but most were less than 0.05 limit for passage of the test. The majority of products stained just slightly more than filter paper, but a few stained quite heavily. Overall, 10 (15%) of the archival products failed the staining criterion.

The results of this evaluation of 66 commercially available archival products have an important lesson for archive managers: Not all enclosures offered in the marketplace are safe to use with photographs. Vague descriptors such as "acid free" (most of the failed products were so described) do not guarantee inertness toward photographs. In some cases, the high prices paid for "archival" enclosures are actually buying materials more harmful than grocery bags or newsprint. It is essential that consumers of photographic enclosures take steps to ensure the inertness of the archival products they use in collections. By insisting that enclosure manufacturers demonstrate compliance with ANSI IT9.2, and specifically passage of the Photographic Activity Test, they can provide themselves with reasonable assurance of satisfactory performance.

Performance of Archival Products in Perspective

The performance of the 66 archival products can be put into perspective by comparing them with the behavior of some of the known good and bad "benchmark" materials. This data illustrates that by and large, photographic enclosures have come a long way from the truly dreadful materials that were so common in the past. For example, two 1930's portrait studio folders, one gray and the other dark green, were tested. The prints inside these folders showed fading and mirroring where they had been in contact with the overmat part of the folder. Both failed all three P.A.T. criteria by large margins. The fading they caused were among the worst of all 90 materials. Their staining was about 7 times the maximum acceptable limit, and they were heavily mottled.

But it is also important to note that the fourth worst fading performance of all 90 materials was given by an "archival" product, a 2-ply white rag board. Two out of the three Japanese repair tissues tested failed the fading criterion. There appeared to be no difference in product performance related to the presence or absence of carbonate buffering. The interactions between photographic materials and enclosures are obviously more complex and varied than the commonly used archival descriptions such as "acid free" allow

for. An empirical evaluation such as the P.A.T. is a vital check for unforeseen harmful effects. Although it is a demanding and rigorous test method, there are numerous products on the market which meet its requirements and are demonstrably safe to use in archives.

Practical Advice in Choosing Photographic Enclosures

Some practical advice to archive managers in choosing enclosures appropriate for photographic use:

1. Choose products which explicitly state that they meet the requirements of ANSI IT9.2.

2. Choose products which the manufacturers identify as intended primarily for the photographic application.

3. Deal, if possible, with suppliers who are familiar with the special needs of photographs.

4. In the absence of 1, 2, and 3 above, choose rag paper and board products.

5. Avoid highly colored papers and boards, especially black.

CONCLUSION

Little is known about the specific mechanisms by which poor-quality enclosure materials harm photographs. The importance of enclosure quality, however, is well established. Specifications given in ANSI IT9.2, in particular the Photographic Activity Test, represent the best assurance of safe, inert enclosure materials.

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SUMMARY

The potentially harmful effects of storage enclosure materials and adhesives on photographs are reviewed. The specifications for enclosures provided in ANSI Standard IT9.2 are summarized. Recent research at the Image Permanence Institute has yielded a greatly improved accelerated test method to evaluate enclosure quality. The results of using the improved "Photographic Activity Test" on 90 enclosure materials, including 66 archival products, are given. Practical guidelines for archival managers on choosing photographic enclosures are also given.