When Due Diligence Isn't Enough: Case Materials Revisited

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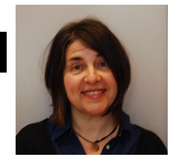


Introduction:

In 2010 The Walters Art Museum received a Conservation Project Support grant from the Institute of Museum and Library Services (IMLS) to support the retro-fit of cases housing the museum's permanent collections of ancient, Medieval, Islamic and early Renaissance art. Over a period of less than 6 years, this casework constructed of Medex (a formaldehyde-free wood panel product used successfully in the past at the Walters) had caused the notable deterioration of a variety of material due to the emission of volatile organic compounds (VOCs). Salts efflorescing from ceramics and fills on stone, voluminous white corrosion on metals and tarnishing of silver were all noted. Plush fabrics including velvets and ultrasuedes were used, for these particular cases and during the course of this project, it was determined that they too played a role in the rapid deterioration of the collection.

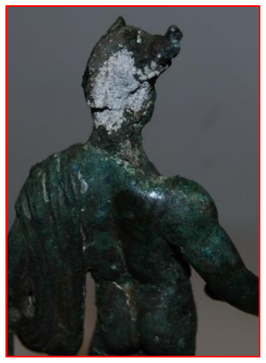
Contributing factors to the problem:

- The Walters had approved the use of Medex based upon Oddy tests performed in the past. Since that time there may have been a change in the formulation of the Medex that contributed to the increase of acid emissions.
- The design of the cases in this installation included better sealed vitrines, which inadvertently concentrated the harmful vapors within the display area.
- Elevated RH of casework due to change in venue of production of casework to off-site location.
- Case design incorporated a large volume of material: blocks, label rails and plush fabrics.

Efflorescing salts along plaster repairs to this glazed stone tilapia fish from Egypt, 18th Dynasty, 1550-1292 BCE, WAM 48.1534. The salt is tentatively identified as thecotrichite, a calcium acetate chloride nitrate efflorescence.[1]

Tarnish on Phoenician silver repoussé bowl with hunting scenes, 8th-7th c. BCE, WAM 57.705. The acidic environment accelerated the silver sulfide corrosion rates of the uncoated silver on display in the affected cases.

Salts efflorescing from the spout of a Mycenaean jug, 1400-1200 BCE, WAM 48.2098.



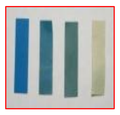
Corrosion on lead plug from ancient Roman bronze figurine. WAM 54.748

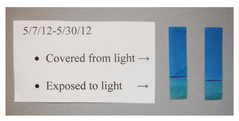
Acid Detection Strips, A-D strips were used to confirm the presence of acidic vapors. A-D strips are paper-based indicators which use bromocresol green. A-D strips were developed to detect acetic acid but can detect other acids as well. Green indicates a pH of 5.4 and below and yellow of pH 3.8. Within an hour of placing this strip in the case with Roman bronzes, it turned yellow/green indicating an acidic environment. (Nicholson C. and O'Loughlin, E 1996. The use of A-D strips for Screening Conservation and Exhibit Materials", *The Book and Paper Annual*, Volume 15).

Case Fabrics and their contribution to VOC's:

Velvets and ultrasuedes approved through the use of the Oddy test initially did not cause the A-D strips to react. Several months after the fabric swatches were placed in polyethylene bags with an A-D strip and stored in the dark, the A-D strips changed dramatically, indicating a problem with the fabrics as well. We do know that the acid content was not solely from the fabric, as cases using pH neutral fabric were also affected.

Velvet and ultra suede fabrics incorporate formaldehyde in the dyeing process. Synthetic resins such as ethylene urea melamine formaldehyde is added to velvets to make them more resistant to crushing. The formaldehyde from the resin off-gasses slowly overtime when exposed to light (Dadd, Home Safe Home, New York: Jeremy P. Tarcher/Penguin 2004.





Because the bromocresol dye fades on exposure to light simple light fading tests were done to try and distinguish light fading from acid reaction when the strips were placed in display cases for a period of time.
The image on the left shows fading of the strips when exposed to lab lighting conditions over a 3 week period. This was important to assess as we hope to continue to use the A-D strip to help monitor conditions in our new cases.
The photo on the left shows a series of strips with corresponding increase in light exposure until no color remained.
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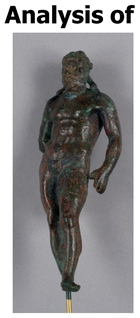
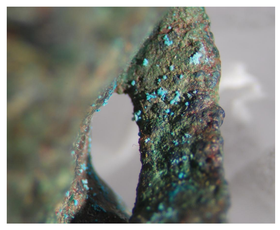
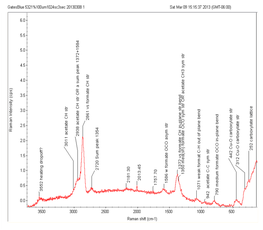
Analysis of Corrosion Products:



Bronze Herakles with detail of corrosion at right





Acetates were present on the salts from this vessel, WAM 48.2098, see detail above. They were detected using FTIR Spectroscopy by Dr. Jennifer Giaccai, then Conservation Scientist at the Walters Art Museum

Detail of blue corrosion on found on surfaces of ancient bronzes like this figure of Herakles Greek, 3rd c. BCE, WAM 54.1005. The corrosion was analyzed using Raman Spectroscopy at the Museum Conservation Institute by Dr. Odile Madden . The corrosion contained copper in conjunction with formates and acetates.

Acid Retention in Porous Materials:

Throughout the duration of the project it was noted that porous materials that had come to equilibrium in a case environment saturated with organic acids, once removed from that dynamic, were releasing acids themselves. This was observed when ceramics, ivories and even some corroded metals were placed in polyethylene bags with A-D strips overnight. On many occasions there was a notable change in acidity as in the two vessels at left where you can see the green color of the A-D strip. In most cases we found it effective to bag the ceramics with repeated changes of Micro-chamber Paper until the A-D strips no longer registered acid levels as seen on the near left image. This effectively removed any of the physically bound acetates. In cases where the object retained a substantial acid level, soaking to remove the chemically bound acetates was required.

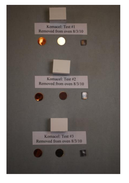
Finding the right solutions: Identification and introduction of new case materials

IMLS supported Exhibition Technician Michael Bouyacas using a conventional iron to apply Marvelseal 360 to the silica gel sub compartment.

- The first step in the retro-fit was to cover all exposed Medex surface with heat-sealed Marvelseal 360, tested and shown to significantly reduce the VOC emissions from the Medex.
- Case design included painted surfaces that could not be Marvelsealed and so new products were evaluated as a replacement for Medex building material.
- Komatex (synonymous with Sintra) an unplasticized polyvinyl chloride was among the materials tested. It performed well with both Oddy tests and testing with A-D strips. Conservators have been rightly cautious about the use of PVC in the past, but this has often been connected to the inclusion of plasticizers absent in the Komatex. PVC is durable and inert when not exposed to extreme heat or light.
- Dibond, a rigid aluminum polyethylene sandwich, and 9 lb Ethafoam were also introduced as interior case construction materials.

A-D strips were used as an effective tool for identifying the presence of organic acid VOC in cases and to help identify new materials for case construction. See at far left an interior case block with ultrasuede fabric covering –note green color of A-D strip. The central sample is a block constructed of Dibond and Ethafoam. The third sample is Ethafoam, polyester foam.

IMLS supported conservation technician, Katie Posthauer, preparing blanks for the Oddy test. Below Katie is seen performing the sodium azide test on newly selected case fabrics to detect the presence of reducible sulfur.



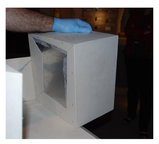
Oddy tests performed on variety of PVC products show good results for copper, silver and lead.

New specifications for Permanent Case Installations:

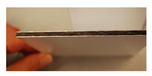
Interior of silica gel vitrines and blocks constructed of Medex are covered with Marvelseal 360.

- Case decks, backboards and blocks wherever possible are constructed of Dibond, a polyethylene sandwiched with aluminum skin. In some cases Ethafoam has been bonded to the surface to create a plank like thickness for building purposes.

Silica gel compartment beneath case deck

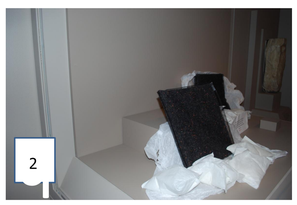


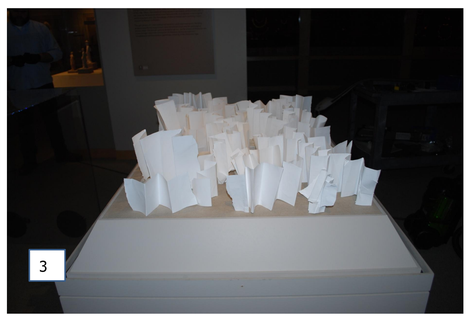
Underside of display block constructed of Medex and lined with Marvelseal 360.



Cross section of Dibond sheet showing polyethylene core with aluminum skin.

Underside of test block constructed of Dibond. Recent tests have included 9 lb. Ethafoam planks secured to Dibond facing. Adhesives are still being tested for use in permanent display.





1. Silica gel compartment doors are lined with Pacific Silvercloth to act as a scavenger for sulphurous gases entering from outside the case.
2. Carbon Web #375 carbon filters are placed first above the deck days prior to the reinstallation of art objects. Once objects have been installed, they are placed below the deck to continue to act as a sorbent for any residual VOC's being emitted from objects.
3. MicroChamber paper is also distributed within the case as an adsorbent prior to reinstallation of objects.
4. Passive indicators to monitor case conditions include: A-D strip, RH and temperature strips and copper, silver and lead coupons.
5. Walters staff reposition each object using templates, photos and existing mounts. Art handlers Mike Mckee and Gill Furoy reinstalling objects after retro-fit of cases.
6. Where ultrasuede and velvets were once used, new Benjamin Moore low VOC paints are matched to the previous fabric color. Mylar separators are used wherever necessary between painted surfaces and metals or porous surfaces.

The Walters would like to acknowledge the generous support from the Institute for Museum and Library Services (IMLS) who has funded the retro-fit of Phase I and Phase II of problematic cases at the Walters Art Museum. Thanks also to Dr. Odile Madden from the Museum Conservation Institute, MCI, for performing Raman Spectroscopy and Jennifer Giaccai for her work on the FTIR and XRF . Thanks also to current Walters staff Terry Drayman-Weisser, Meg Craft, Mike Mckee, Gill Furoy, Joan Elisabeth Reid, Asa Osborne, Michael Bouyacas, Wayne Johnson, Ashley Boycher, Susan Tobin, Susan Wallace, Marden Nichols, Martina Bagnoli and former interns Lauren McMullen, Jessie Arista and Rachel Penniman for their participation on the project.

[1] X-ray fluorescence analysis was performed at the Walters Art Museum with the assistance of Lauren McMullen and Conservation Scientist Jennifer Giaccai. Analysis identified calcium and chlorine in the efflorescence. This may support the identification of thecotrichite $\{Ca(CH_3COO)_3CL(NO_3)_27H_2O\}$, a salt known to form on museum objects containing calcium and that have been contaminated with chloride salts and nitrate salts and then exposed to acetic acid vapors. (Gibson, L.T. Cooksey, D. Littlejohn, K.Linnow, M. Steiger, and H. Tennet. 2005. The Mode of Formation of Thecotrichite, a Widespread Calcium Acetate Chloride Efflorescence. *Studies in Conservation.* 50:284-194.