



Conserve O Gram

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Monitoring Acidic Off-Gassing Of Plastics

Deteriorating plastics can emit acidic vapors that can contaminate and degrade other materials. It is important to determine if a plastic is off-gassing so that appropriate measures can be taken to protect the collection, including increasing ventilation and isolating plastics from other materials.

This *Conserve O Gram (COG)* outlines simple monitoring options that will help determine if a plastic is off-gassing acidic vapors by using:

- A-D Strips
- Metal coupons

Refer to *COG 8/4* “The Care and Identification of Objects Made from Plastics” before determining the best monitoring method for plastic, and for guidance on how to care for and house your plastics collections, and on how to recognize signs of deterioration.

A-D Strips

A-D (acid-detecting) strips are acid-base indicator papers that turn from blue through shades of green to yellow when acidic vapor is present. The more yellow the color, the more acidic vapor is present. The quicker the color change, the higher the acid concentration.

The strips are made with bromocresol green dye as a sodium salt on a paper substrate. They were developed for use with cellulose acetate film but are sensitive to acids emitted from a

variety of deteriorating plastics, as well as other materials such as wood. Since the indicators can be sensitive to acids emitted from a range of materials, it is important to isolate the plastic artifacts in question when monitoring. These monitors are best for short-term monitoring so plastic artifacts that are of concern should be periodically isolated and monitored.

Monitoring:

- Select a sealable container (such as lidded polyethylene box).
- Put the plastic object in the container with the A-D strip next to (but not touching) the object.
- Seal the container.
- After 24 hours, check the strip for a color change.
- A green or yellow change from the original dark blue is a positive reaction for acidic vapor.
- Keep monitoring for at least one week as it may take awhile for the acid to build up enough to cause a reaction.
- Compare the reacted strip to an unused strip. Take a photograph to record the reaction, if desired.

Keep in mind:

- Observe and note the reaction immediately. Once the strips are removed from the acidic environment, they will revert back to their

original blue color. Though the color will revert, the strip cannot be reused.

- The strips are light sensitive so they cannot be used for long-term monitoring.
- Cold temperature or low relative humidity [RH] slows reaction.
- It is possible to have a degraded plastic that is no longer off-gassing.
- Store unused strips in the original Marvel-Seal® bags as shipped. The MarvelSeal will help keep out light as well as acidic vapor in the environment that could cause a reaction and exhaust the strips.
- Do not reuse containers that were used when a positive reaction occurred. The container can absorb emitted acids and affect subsequent tests.
- It is a good idea to test a control (not off-gassing) and a known (off-gassing) material to make sure that your test set-up is appropriate.



Figure 1. Blue A-D test reference strip above reacted green/yellow A-D strip

Metal Coupons

Since metals will corrode in the presence of acids, metal coupons can be used to detect off-gassing plastics. Metals tend to have a slower reaction than the indicator strips, making them a good choice for long-term monitoring in storage or display. They can be used in situ without isolating plastics into separate containers.

Silver, lead and copper are good choices because of their sensitivity and availability and are commonly used in conservation material tests, such as the Oddy Test. Thin metal sheets can be purchased from jewelry suppliers or other sources and cut into desired sizes. A thick gauge is not necessary. Make sure that the metals are as pure as possible to ensure more reliable results.

Monitoring

- Choose metal coupons to use. If using lead coupons, be sure they are new since disturbing the surface through polishing and cleaning can be a health hazard.
- Cut to size with metal cutters. The size should be uniform between the coupons.
- Clean copper and silver coupons:

Polish copper and silver coupons using metal polish and felt-tipped rotating polisher or stiff bristle brush until the coupons are shiny. Use gloves and safety goggles, see *COG 1/12* “How to Select Gloves: An Overview for Collections Staff,” 2010. Do not polish the lead coupons. Remove polishing residue with a lint-free cloth.

Clean the copper and silver coupons by submerging in Mr. Clean® liquid cleaning solution (will not leave a residue like other cleaners)

Remove coupons and clean all sides with a soft brush or toothbrush and then rinse in distilled or deionized water.

Clean coupons with acetone either by submerging or applying with cotton swabs or cotton pads. Clean until all signs of corrosion and residue are removed. Use gloves and safety goggles when using acetone, see *COG 1/12*.

- After polishing and cleaning, handle cou-

- pons with tweezers. Place metal coupons next to but not touching the object.
- Monitor weekly at first. If there is no corrosion on any of the metals, monitor monthly or as deemed appropriate.
 - Positive reactions for metals:
 - Silver –dark gray tarnish
 - Lead – gray or white
 - Copper – often green but may be brownish or black
 - Photograph the reacted strip compared to an unused, clean strip to record the reaction.

Keep in Mind

- For long-term monitoring, DO NOT seal plastic objects in closed containers. Ventilation is important for preventing the build-up of acids that accelerate degradation of the plastic itself.
- Do not allow the plastic object and metals to touch.
- Cleaning metal coupons prior to use helps ensure accurate results.
- When preparing the metal coupons wear appropriate personal protective equipment, including gloves, see COG 1/12
- It is a good idea to test a control (not off-gassing) and a known (off-gassing) material to make sure that your test set-up is appropriate.



Figure 2. Copper (Cu), Silver (Ag) and Lead (Pb) coupons cut and cleaned for monitoring.



Figure 3. Top: Copper coupon after 4 weeks of exposure to off-gassing cellulose nitrate
Bottom: Copper coupon reference

Positive Reactions

Whichever monitoring method you use, if you get a positive reaction, consider the following:

- If monitoring several objects at once, such as in storage or display, determine which object(s) are off-gassing. To do so, isolate and individually monitor.
- Remove deteriorating or suspicious objects.
- Determine if the objects can be safely kept in the collections.
- Find ways to increase ventilation to prevent the build-up of acidic vapor.
- If the plastic object is in direct contact with another material, create a barrier to block acids from migrating. Metal, aluminum foil, glass or Mylar® are usually effective.
- Document the object's condition in writing and photographs.
- If the off-gassing is found to be excessive, refer to the NPS *Museum Handbook*, Part I, Ch 11, E. Hazardous Objects in Collections.
- Review COG 8/4 "The Care and Identification of Objects Made from Plastics" for additional guidelines about caring for plastics.

Conclusion

These two monitoring methods can be used in tandem. Metal coupons can be used for long term monitoring in storage and in display cabinets. The A-D strips are used for short-term, directed monitoring.

Note: With each monitoring method, other materials can cause positive reactions. If it is not certain that the plastic is the source of the acidic vapor, isolate it and monitor again.

References:

Fenn, Julia. "The Cellulose Nitrate Time Bomb: Using Sulphonephtalein Indicators to Evaluate Storage Strategies," *From Marble to Chocolate: The Conservation of Modern Sculpture*, Jackie Heuman, ed., *Tate Gallery Conference 1995*. London: Archetype Publications, 1995.

Image Permanence Institute. *User's Guide for A-D Strips Film Base Deterioration Monitors, Second Edition*. Rochester: Image Permanence Institute, Rochester Institute of Technology, 2001.

Schiro, Mara. "Getty Protocols," *Oddy Test Protocols*. American Institute for Conservation of Historic and Artistic Works, Conservation Wiki. http://www.conservation-wiki.com/index.php?title=Oddy_Test_Protocols

Shashoua, Yvonne. *Conservation of Plastics, Materials science, degradation and preservation*. Oxford: Elsevier Ltd., 2008

Materials and Supplies

A-D Strips

Image Permanence Institute. www.imagepermanenceinstitute.org

Silver, lead and copper sheets are available from various online retailers.

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Table 1. Monitoring Plastics

Monitor	Use	Original Appearance (or no reaction)	Positive Reaction
A-D Strips	Reacts with off-gassing acids from a variety of plastics	Blue	Shades of green to yellow
Metal Coupons (silver, lead, copper)	Reacts with off-gassing acids from a variety of plastics	Silver – silver Lead – gray Copper – orange	Silver – tarnish Lead – white or dark gray Copper – green (though may be black or brown)

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