NATIONAL PARK SERVICE

Conserve O Gram

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Care and Identification of Objects Made from Plastic

Many museum collections contain objects made wholly or partly from plastics. Developed in the late 19th century, the first man-made plastics were produced from modified natural materials. Later, plastics were made from fully synthetic materials that were used extensively throughout the 20th century. All plastics are subject to aging and degradation. With proper environmental conditions and close monitoring, the degradation process may be mitigated.

This *Conserve O Gram* provides guidance with the identification and care of semi-synthetic and synthetic plastic objects. Photographic film is not discussed. See the *Museum Handbook*, Part 1, App. M: Management of Cellulose Nitrate and Cellulose Ester Film and *COG* 14/8, Caring for Cellulose Nitrate Film, for guidance on managing film collections.

Many plastics are inherently hazardous and may present a health risk. Work in a well-ventilated area, wear nitrile gloves when handling plastics, and refer to *COG* 2/10, Hazardous Materials in Your Collection.

Plastics Identification

Plastics are difficult to identify. To determine the type of plastic, look for a patent number, trade name or trademark on the object, or printed information on original containers and packaging. Use Table 1, Plastic Identification and Care, as a guide. If necessary, consult a conservator who specializes in plastics to aid in the material identification of an object.

Causes of Deterioration

The cause of deterioration may be one, or a combination of the following:

- **Age.** The earliest plastics are often the most vulnerable because many of the chemical additives used during the late 19th and early 20th centuries are unstable.
- **Composition.** Many plastics are chemically unstable. Several incorporate chemical 'plasticizers' and other fillers. Plasticizers are low-melting solids or high-boiling organic liquids added to hard plastics to impart flexibility. They migrate to the surface over time leaving the material tacky, and /or brittle. Plasticizer migration can also cause warping and distortion.
- **Environment.** Pollutants, gases, high levels of visible and ultraviolet light, and high or fluctuating temperature and relative humidity (RH) levels accelerate deterioration.
- **Handling and cleaning.** Poor handling and improper cleaning techniques cause damage and accelerate deterioration.

Signs of Deterioration

Before an object exhibits visual clues, it may emit an odor. Acidic odors, such as vinegar, or an odor of camphor, may indicate the object is in the early stages of degradation. The first visible signs of deterioration are weeping, tackiness, discoloration, distortion, warping, crazing, and /or embrittlement. Once these are

present, deterioration is occurring at a rapid rate and is irreversible.

Figure 1. Severely degraded cellulose nitrate comb shows crazing, cracking, and discoloration (circled). Internal and /or surface crazing is often the first sign of degradation and precedes brittleness and fracture.

Figure 2. Distorted and discolored cellulose acetate comb; upper band has severe crazing and a white pow dery bloom (circled) caused by migrating plasticizer.

Recommendations

Segregate. Plastics can adversely affect neighboring objects and archives as many plastics release corrosive gases. House plastics separately, especially away from metals and organics. Store like plastics together. Make sure objects are not in contact with each other. For objects made of plastic and other materials, such as a cellulose nitrate knife handle with a metal blade, create a barrier to protect the metal by wrapping the blade in polyester film, such as Mylar®, leaving the handle exposed.

Ventilate. Most plastics benefit from being stored or exhibited in a well ventilated environment. Do not store in impermeable bags or tightly wrapped packages. Many plastics can emit gases, which when trapped, can accelerate deterioration.

Environmental control. Deterioration may be slowed by using products that help maintain a suitable environment. Cellulose nitrate and cellulose acetate materials should be stored or exhibited in a well ventilated environment. If ventilation is not possible, as in a closed container or exhibit case, store with gas adsorbents, also known as molecular traps and scavengers. These products adsorb and lower the concentration of gases in the air.

Objects made from polyvinyl chloride and polyurethane foam benefit from an oxygen free environment. Store these materials with an oxygen absorber to reduce the oxygen concentration in the container. See Table 1 for optimum environmental conditions for specific plastics and the materials and supplies list for suppliers of adsorbents. Consult a conservator for guidance on using these products safely and effectively.

Light. Visible and especially ultraviolet light is damaging to all plastics as it can cause discoloration and accelerate degradation. Keep light levels low. Follow the standards for especially light sensitive materials, in the Museum Handbook, Part 1, Ch. 4:35.

Temperature. Generally, the higher the temperature, the faster the rate of deterioration. Store plastic objects at a cool, stable temperature below 68° F and avoid fluctuations.

Relative humidity. Plastics require a stable RH range. Fluctuations may cause brittleness, stress, warping, and cracking. The required level depends on the type of plastic. See Table 1 for recommended environmental conditions

for specific plastics.

Monitor. Inspect regularly. Check for unusual odors, visual clues and pests. Wood fillers in some Phenol based plastics are susceptible to pest attack. Casein plastic is a protein based material derived from milk and may attract parasites. Monitor every 6 months and remove any objects that appear to be deteriorating

Labeling

Do not use a solvent or water based solvent barrier layer and/or a marking pen to label plastic objects. Inappropriate materials will cause stress crazing, swelling or distortion. Some pigments in inks will accelerate degradation in plastics. Removal of labels with solvents or water may damage the object. Consult a conservator before removing old labels. Label with acid free tags or a soft marking pencil. Some objects will not accept pencil and may not have a place to tie a tag. Place acid free tags or labels printed on acid free paper in a tray or open container with the object. When labeling an object with non-plastic parts, label the non-plastic component that is not in contact with, or adjacent to, the plastic element. See *Museum Handbook*, Part II (2000), App. J: Marking, Section E, for more information on labeling plastics.

To care for plastics:

DO	DO NOT
Work in a well-ventilated area, wear protective clothing and use nitrile gloves. Change gloves after handling an object that appears to be degrading to avoid the transfer of degradation.	Use cotton gloves. Toxic materials may leach out and create a health risk. Cotton can also leave lint on sticky or tacky objects.
Use acid free unbuffered tissue unless the object is degrading as a tacky object may adhere to the tissue.	Use buffered tissue paper. Alkaline buffers can accelerate degradation in some plastics.
Use inert materials and acid free containers for storage and display.	Use cases made from wood, wood fiber products, or fiberboard.
Store plastics in a cool, dry, dark, and well ventilated environment. Use adsorbents with certain plastics to trap gases and vapors in closed containers and cases.	Store most plastics in sealed bags, boxes or tightly wrapped packages.
Separate by type of plastic and store like plastics together. Make sure objects are not in contact.	Store plastics with other types of materials, especially metals and organics.
Support plastic objects with inert materials such as Ethafoam®or Mylar®	Support plastic objects with materials that off- gas or may change shape over time, such as bubble wrap.
Clean by dry wiping, brushing or vacuuming.	Use solvents or water to clean plastic. If in-depth cleaning is needed, consult a conservator.
Monitor plastics regularly and document condition. Remove degrading objects.	Store degrading objects with ones in good condition.

References:

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Plastics Historical Society, http://www.plastiquarian.com

Quye, Anita and Colin Williamson, ed. *Plastics: Collecting and Conserving.* Edinburgh: NMS Publishing Limited, 1999.

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

Williams, Scott, Canadian Conservation Institute. "Care of Objects Made from Rubber and Plastic." CCI Note 15/1. Ottawa: Canadian Conservation Institute, 1997.

Materials and Supplies

Gas Adsorbents:
ScienceLab.com, Inc. [activated charcoal]
14025 Smith Rd.
Houston, Texas 77396
Phone: (800) 901-7247
www.sciencelab.com/

University Products [activated carbon cloth]
517 Main St., PO Box 101
Holyoke MA 01041-0101
Phone : (800) 628-1912
www.universityproducts.com

Purafil, Inc. [Purafil]
2654 Weaver Way
Doraville, Georgia 30340
Phone: (800) 222-6367
www.purafil.com

Ageless® Oxygen Absorber:
Mitsubishi Gas Chemical America, Inc.
655 Third Avenue, 24th Floor,
New York, NY 10017
Phone: (212) 687-9030
www.mgc-a.com/AGELESS/

Keepsafe Systems
600 Main Street
Tonawanda, New York USA 14150- 0888
(800) 683-4696
http://keepsafe.ca/

Marianne Chalifoux Zephir
Museum Technician
Marsh-Billings-Rockefeller NHP
54 Elm St.
Woodstock, VT 05091

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Table 1: Plastic Identification and Care

Material	Common/Trade/ Company Names	Year Introduced / (Major Commercial Production Dates)	Characteristics	Early Applications	Degradation Characteristics	Optimum Environmental Conditions
Cellulose Nitrate (CN)	Celluloid®, French Ivory, Ivoride, Parkesine®, Pyralin, Pyroxylin, Xylonite®	1862 (1870-1930s)	Often imitates tortoiseshell and ivory. Ivory CN has faint, straight parallel lines. Can also be colored. Flammable.	Hairbrushes, combs, hair accessories; manicure sets, fans. Toys, figurines; jewelry, billiard balls, washable collars & cuffs.	May emit camphor odor (mothballs). Cracking, blistering, crazing, crumbling, powdery hazy residue, weeping, misting or fogging	Stable temperature below 68°; stable RH between 30%-40%. Well ventilated, away from heat, open flame. Segregate; use gas adsorbents if stored in closed container.
Cellulose Acetate (CA)	Acetate Cellanese®, Lumarith, Tenite, Rayon®	1869 (1905-1920s)	Hard, glossy, bright colors. Can also be transparent. Also synthetic fibers.	Combs, dolls, toys, pen/pencil cases, eyeglass frames. Clothing and textiles.	May emit odor of vinegar. Crazing, cracking, blistering; white powdery bloom, warping, weeping.	Stable temperature below 68°; stable RH between 30%-40%. Well ventilated, segregate; use gas adsorbents if stored in closed container.
Casein	Aladdinite, Ameroid, Karolith, Galorn, Galalith, Erinoid Lactoid	1899 (c. 1914-1950s)	Glossy, polished. Variety of colors; pastels, and mottled.	Buttons, buckles, gaming chips, dice, jewelry, fountain pens.	Crazing, cracking. Susceptible to parasitic attack.	Stable temperature below 68°; stable RH of 60%.
Phenol formaldehyde	Bakelite (before 1939), Durez, Durite, Indur, Resinox, Redmonal	1907 (1909-1930s)	Dark colors- black, red, brown. Always opaque; may have tiny visible fillers- wood flour or flakes; cotton fibers, mica.	Electrical insulators & components; knobs, fittings. Telephones, cameras, appliance components & casings. Billiard balls, jewelry, furniture, laminates.	Cracking, discoloration, fading. Susceptible to insects, fungi. Can also bloom.	Stable temperature below 68°; stable RH of 30%-50%.
Cast phenolic	Catalin, Carvacraft, Marblette	1928 (1928-1940s)	Bright colors, can be opaque, clear or white. Imitates amber and jade.	Jewelry, buttons, game pieces, toys.	Color change, yellowing.	Stable temperature below 68°; stable RH of 30%-50%.
Thiourea-formaldehyde and urea formaldehyde	Bandalasta Ware, Beetleware, Beatl, Plaskon	1920 (1928-1950s)	Light colors, even white; mottled, marbleized. Opaque. Has wood flour or pulp fillers.	Tableware, picnic sets, small appliances, radio casings, laminates.	Fading, cracking. Susceptible to insects because of fillers.	Stable temperature below 68°; stable RH of 30%-50%.

Table 1: Plastic Identification and Care (continued)

Material	Common/Trade/ Company Names	Year Introduced / (Major Commercial Production Dates)	Characteristics	Early Applications	Degradation Characteristics	Optimum Environmental Conditions
Polyvinyl chloride (PVC)	Vinyl, Naugahyde, Duran/ Duraleather, Fabrilite, Ultron, Vinylite	1926 (1930s+)	Rigid or flexible; imitates fabric, leather.	Imitation leather clothing and upholstery; shower curtains. Dolls, records, electrical coatings, notebook covers.	Chemically unstable. Rigid PVC is more stable. Flexible vinyl is unstable due to migrating plasticizers. Surface deposits- sticky, tacky, weeping. Distortion, discoloration, stiffening, embrittlement, cracking.	Stable temperature below 68°; stable RH between 30-40%. Segregate. Store in closed non-adsorbent glass or polyester container. Use oxygen adsorbents. Use a rigid support to prevent distortion.
Polystyrene	Styrene, Styron, Lustrex, Plexene, styrafoam, Styrofoam™	1929 (1930s+)	Glasslike, rigid, glossy, wide color range. Also produced as foam.	Post WW II toys; house wares, packaging. Disposable cups (foam).	Cracking, warping, discoloration.	Stable temperature below 68°; stable RH of 30%-50%.
Melamine formaldehyde	Melamine, Melmac, Meladur, Prolon, Texasware, Boontonware	1933 (1935-1940s+)	Bright colors, opaque, hard.	Tableware, picnic ware, kitchenware, laminates.	Fading, discoloration; scratches easily.	Stable temperature below 68°; stable RH of 30%-50%.
Polyethylene (PE)	Polythene, Fortiflex Poly-T	1933 (1940s+)	Soft, but tough; flexible, waxy; colorful. Lightweight.	Tupperware®; food & beverage containers, house wares.	Waxy, warping, discoloration.	Stable temperature below 68°; stable RH of 30%-50%. Store upright with support to prevent warping.
Polyurethane (PU)	Polyurethane foam, Lycra®, Spandex®	1937 (1950s+)	Very versatile: Hard and rigid (coatings), rigid and flexible foams, rubber (synthetic). Elastic fibers.	Flexible foams for padding in furniture; hard coatings. Foam toys, novelties. Clothing, textiles, imitation leather, imitation suede.	Polyurethane foams are very unstable. Crumbling, weeping, discoloration. Loss of elasticity.	Stable temperature below 68°; stable RH between 30%-40%. Segregate. Store with oxygen adsorbents. Use a rigid support to prevent distortion.
Polyamides	Nylon	1938 (1940s+)	Imitates silk. Flexible and rigid. Naturally white; can be colored.	Hosiery, bristles in toothbrushes, hair-brushes, paintbrushes. Combs, WW II parachutes; machine gears, rope.	Yellowing, discoloration; embrittlement, warping, fraying.	Stable temperature below 68°; stable RH of 60%.