
ADVICE SHEET

The effects of storage and display materials on objects



Introduction

Many materials that may seem suitable for storage or display purposes can cause serious damage to museum collections. They can cause corrosion, discolouration or deterioration of objects, either because they give off harmful vapours or because they are in direct contact with the museum object. These processes of corrosion, discolouration and deterioration are speeded up by high temperature and/or high humidity levels.

Harmful volatile substances include formaldehyde, acetic acid, formic acid, sulphuric acid, sulphur dioxide, nitrogen dioxide, ozone, and ammonia gas.

Sources of these substances include wood products, acrylic resins, paints, lacquers and varnishes, glues and adhesives, pesticides, insecticides, fungicides, furnishing fabrics, adhesive tape and other sticky materials such as "Plasticine" and "Blu-tack". Electrical machinery such as electrostatic air cleaners and some photocopying machines may produce ozone. Burning fossil fuels can produce harmful vapours and air-borne soot particles.

What does this mean for the objects in a museum collection?

All **metals** are affected by harmful vapours released by wood, although some more than others. Lead objects stored in oak cabinets have shown considerable corrosion caused by acetic acid. Silver and copper objects, metal embroidery threads, sequins and silver photographic images will tarnish as a result of sulphur gases, released by wool.

Paper objects, books, maps, prints, drawings, watercolours, letters and charts will suffer from discolouration and deterioration when mounted in cheap, acidic mountboard. Adhesive tape ("Sellotape", masking tape, etc.) will contract and eventually separate from the paper it is used on, leaving a sticky yellow stain that is usually difficult or impossible to remove. Some watercolour pigments are sensitive to acidic and other vapours.

Photographic material, slides, prints and negatives are affected by the vapours and plasticisers used in polyvinyl chloride (PVC) and some other plastics.

Daguerreotypes' metal plates are tarnished by sulphur gases and paper prints are affected by oxides, resulting in a bluish metallic sheen called "silver mirroring".

Textiles will deteriorate more rapidly when they are in contact with acid-releasing materials, such as cheap mount board and acidic cardboard rollers. New fabrics for displays may have been treated with dyes, fire retardant treatments and waterproofing or other finishes. The materials used for these treatments may cause fading and other damage to historic textiles.

Pins and tacks used for mounting and framing will rust when in contact with **textiles** or other materials with natural moisture content. The rust may cause deterioration of the pinned or tacked object.

Bone, ivory and many other materials are adversely affected by the vapours from rubber and urethane foam ("foam rubber", vinyl tiles, flooring adhesives and rubber backed carpets). Volatile sulphur compounds from rubber will cause a yellow or orange discolouration in ivory and cellulose acetate ("celluloid") artefacts. The plasticiser in PVC is also an excellent plasticiser for celluloid objects!

Magnetic tapes (cassettes, reel-to-reel and computer) are affected by magnetic sources, such as catches on doors.

Objects made of **rubber** and **modern plastics** can be very unstable and are easily affected by plasticisers released by some wrapping materials (such as PVC bags, sleeves and sheeting). Ozone, which is naturally present in the air and can also be generated by electrical machinery, speeds up the deterioration of rubber. Metals can also have an effect on rubber when in direct contact with it.

Pigments in **feathers** and **ethnographic objects** will fade when affected by sulphuric acid (air pollution, wool felt and fabric).

Formaldehyde, present in many types of wood and composite board, reacts with many different materials to form formic acid, which can be harmful to a variety of museum objects.

How to choose safe materials

Two categories of materials can be distinguished –

1. Materials used to protect, shape or support the object.

In storage these materials are the first layer of protection against dirt, dust and other harmful influences. They are often in direct contact with the object, and should therefore always be as chemically stable as possible, as any harmful substance in them will directly affect the object.

Acid free tissue paper is made out of cotton or linen rags, or highly purified wood fibre materials. It should be lignin free, because lignin will cause the paper to become very acidic. Lignin free paper is usually sold as "acid free", "museum quality" or

"archival quality", but check that these products are indeed acid free by testing them with an indicator pen.

Some acid free tissues contain buffering alkaline compounds. These buffers can help prevent migration of harmful acidic products onto paper objects, but they can be harmful to some other items and should never be used for photographic material and textiles. Acid free tissue is used as interleaving tissue when rolling or storing flat items, and as a wrapping or "padding" material for three dimensional objects.

"Melinex" sleeves, made of transparent polyester sheeting, come in various sizes and are very useful for the storage of photographic material (prints, negatives, slides, plates) and work on paper (prints, drawings, letters, documents, posters and pamphlets). They should not be used for pastels, charcoal drawings and other works with delicate images as the particles of these can migrate onto the sleeve due to static forces. "Melinex" can also be purchased as a continuous film, which can be heat sealed into custom-sized sleeves. (At least one side of the sleeve should be left unsealed.)

Polyethylene (self sealing) bags are available in various sizes and are suitable for the storage of small items. They are free from coatings or plasticisers and are fully inert. Do not use polyvinyl chloride or other plastics that contain chloride or nitrate, as they give off harmful vapours.

"Tyvek" sheeting is made of high density polyethylene fibres and prevents the passage of water in one direction (from the smooth outside to the rough inside), but allows the passage of air in both directions. It can be used to make dust covers for costume, (upholstered) furniture and rolled textiles.

For the mounting of prints, drawings, and other (small) flat objects **acid free mount board** is a good choice. Acid free board is also used for the fabrication of **storage boxes**, some of which may be buffered to protect the contents from migrating acids. As with acid free tissue, these buffered boxes should not be used for vulnerable items such as photographs and textiles, as the buffering substance itself may cause damage to the objects.

"Ethafoam" and **"Plastazote"** are stable polyethylene foams, blown with the use of nitrogen which is inert. They can easily be cut into supporting mounts for three dimensional shapes. They are available in a range of colours, but only the black and white versions are safe for use, as the colorants used in the others may stain or damage objects.

"Perspex" (polymethylmethacrylate) can be made into stands for (small) glass, ceramic and other solid objects in good condition. It can be rather difficult to process, and attention should be paid to ensure that adhesives used do not contain any harmful vapours.

2. Materials used for shelves, cupboards, cabinets and display cases.

These materials are used to create safe environments (cases, cupboards, cabinets) which are to protect the objects inside from the damaging effects of air pollutants (see advice sheet "Air Pollution"), dust, fluctuations in temperature and humidity, light

(in storage) and enthusiastic museum visitors! It is important that, although they are not in direct contact with the objects, these materials do not give off any harmful substances, as the levels can rapidly build up within the closed case or cupboard, thus creating a very harmful environment for the objects rather than protecting them from it.

Metal is the preferred material for display cases and storage shelving or cupboards. It is strong, smooth, inert, non-flammable and does not emit any harmful vapours. However, to prevent rusting in situations with high humidity levels, it should always be covered with a protective layer, preferably a baked enamel finish rather than paint.

Woods produce harmful vapours such as formic and acetic acid and peroxides, although some are worse than others. Freshly cut and unseasoned wood produces the greatest quantities of these vapours. Oak, sweet chestnut, Western red cedar and Douglas fir are the woods most commonly associated with corrosion of metals in contact with them under damp conditions. Teak has been known to cause corrosion of stainless steel and other rust resistant alloys! Iron and steel objects are much more susceptible to the corrosive influence than aluminium, copper or brass. If wood is to be used, choose one of the following: pinewood (especially yellow pine), spruce (except sitka spruce), walnut, elm or magnolia. It should be well seasoned (air dried rather than kiln dried).

Composites, such as plywood, chipboard, particle board and hardboard can cause similar problems, and may also release formaldehyde from the adhesive that is used in these boards. Recently a low-formaldehyde Medium Density Fibre board has been developed, which has shown a much lower formaldehyde emission in tests.

However, the release of acids by wood and wood products is a normal chemical process that cannot be prevented entirely. The only way to minimise the emission of any harmful gases is to seal the wood with a **barrier foil**. Barrier foils consist of a metal foil, which is impermeable to gases, sandwiched between layers of inert plastic. They can be heat sealed onto the wood with an iron and are an effective barrier as long as the foil is intact. Nailing, stapling or drilling holes destroys its effectiveness. It is important to seal the edges of boards as these emit vapours at a higher rate than the other surfaces. As an alternative, **aluminium foil** can be used, but it is much more vulnerable and can very easily be damaged.

Paints, lacquers and varnishes have proved to be virtually useless as a barrier against vapours emitted by wood, and may actually cause problems by their own emission of solvents and other harmful vapours. If they are used to improve the appearance or texture of a surface, casein, alkyd, polyurethane and oil-modified paints and varnishes should be avoided.

Good quality **acrylic latex emulsions** and **epoxy-resins** are considered safe, provided enough time is allowed for the paint to dry thoroughly (check the manufacturer's specifications on how much time needs to be allowed for this). This is particularly important for water-based emulsions, which will form a skin that is dry to the touch hours before all the water has escaped. When boards painted with these emulsions are enclosed in a case or cupboard too soon the humidity level inside the case will rise.

Rigid mounting boards for mounting objects or making text panels in cases come in a variety of light weight materials. They consist of a polystyrene foam or an aluminium or paper honeycomb-structured core, covered on either side with a skin that may be made of acid free paper, plastic or aluminium. Unfortunately some of the core materials may release harmful gases that were used to "blow" the foam, or the adhesive that was used to attach the skins may emit harmful substances. These sheets should always be covered with a barrier foil before use.

Fabrics should be chosen carefully. Wool, all fabrics coated with fire retardants or finishes and foam or adhesive-backed fabrics all have been found to give off harmful vapours and are therefore not recommended.

Undyed and unbleached cotton or linen fabrics are safe to use, but they have to be thoroughly washed and rinsed before use. Dyed fabrics and synthetic blends should always be tested before use. The fastness of dyes can be checked by rubbing the fabric with a piece of white cotton, first dry and then repeated with damp cotton.

Glass is safe for use near museum objects. It is scratch resistant, gas impermeable and is available laminated or coated with UV-filters. Weight may be a disadvantage though, and its low surface temperature may cause condensation and mould growth, also on organic materials that may become damp as a result of the condensation.

Attention should be paid to **cleaning agents** used for glass: they should not contain vinegar or any other harmful substances.

Polymethylmethacrylate ("Perspex") and **polycarbonate** sheets are also acceptable materials, particularly when they have built-in UV absorbing properties. They are lighter in weight than glass and have a higher surface temperature. They have good impact resistance and crack rather than shatter. Disadvantages are the permeability to gases, a relatively soft surface which is easily scratched, and less rigidity which may cause it to bend when large pieces are used. Also, static forces are generated by cleaning the outer surface of Perspex in frames, causing (parts of) the object inside to stick to the inner surface.

Other materials, such as **adhesives** that may be used to join several of the above components, **seals, gaskets** and **labels** should always be checked for the presence of one of the harmful substances mentioned on page one. Hot melt glues (ethylene/vinyl acetate copolymer types), dense polyurethane or cross-linked polyolefin gaskets and Tyvek or acid free paper labels are good materials to use.

Museum Objects

One should be aware of the fact that museum objects themselves react in similar ways to the materials described in this advice sheet. Modern organic materials are most likely to release harmful gases. For instance, badly processed photographs may give off acidic or sulphidic gases that cause embrittlement and discolouration of the paper, and cellulose nitrate ("celluloid") objects release vapours that speed up their own deterioration. These processes particularly occur when the objects are kept

in a confined space (such as a display case, a self-sealing polythene bag or a plastic box), where a concentration of the harmful vapour is allowed to build up. Modern organic materials are therefore best displayed in cases that allow air-exchange. In storage they should be wrapped in acid free tissue paper that will absorb the emitted gases, and they should be stored in a separate part of the storage area where there is adequate air exchange.

Summary

It is good practice to always use materials which are as inert as possible in displays and stores, so that they can be re-used when exhibitions are taken down or stores are reorganised. When working with a limited budget the unsafe materials may be replaced gradually, starting with the ones that are used near the most vulnerable items. If there is any doubt about the use of a certain material, the best thing to do is to have a small sample tested first.

By using safe display and storage materials a safe environment is created for museum objects, which helps preventing further deterioration. This preventive part of conservation is important in the on-going care for museum collections.

Further information and advice

This is one of a series of advice sheets produced by Museums Galleries Scotland on common collections care and preventive conservation issues. For more details and signposting to further sources of advice see our website at:
www.museumsgalleriesscotland.org.uk.

The Collections Trust has a range of collections care advice and guidance available, see the website <http://www.collectionstrust.org.uk/useful-guidance>

Selected reading

Hatchfield, P
Pollutants in the Museum Environment
Archetype, 2002
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