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# *Wood versus Plastic: the museographic materials*

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Because modern numismatic collections are complex, the interaction of numismatic materials and their environment is equally complex. Numismatic materials include metal coins, cellulose based paper money and checks, plastic credit cards and telephone cards, ceramic tokens and other composite materials both as specimens and archival material. Ethnographic currencies further complicate the issue. These will be affected not only by their surrounding storage or exhibit environment but will also interact with each other. In addition the general museum environmental parameters of light, temperature, relative humidity and pollution can change the rates at which these interactions take place.

The first point in understanding exhibit and storage problems and strategies requires the identification of the materials in the collection. This is not always easy. There are traditional metals but modern polymeric materials such as polyesters, polyolefins, polystyrenes, cellulose nitrates and acetates are now finding their way into collections. The variety of materials used can present special problems and the addition of new materials to a collection requires more than a passing thought.

The second point requires that the cases and exhibition materials used in storing and exhibiting collections be as chemically inert as possible and that construction materials react neither with the collection nor with each other.

The first two points are relevant to the local environment of the collection. A third point necessitates environmental control of the storage and exhibit areas and maintenance of the proper air quality, temperature, light, and relative humidity.

## THE COLLECTION ITSELF

Modern numismatic collections contain materials that not only behave differently from the classical metal specimens but also can be modern plastics, exotic metals or cellulosic, ceramic or other composite materials. Archival materials may also be exhibited or stored in association with these objects as well. While the ambient environment of the museum may play an important part in long term preservation of collections, the internal case environment of storage or an exhibit is influenced by the numismatic items themselves. Identification of the collection items is crucial since in small confined spaces such as exhibit or storage cases they may actually determine what the environment is.

Plastics often contain low molecular weight compounds as additives to make them flexible, easier to process, or resistant to light or oxidation. Many of these compounds are volatile or can be leached out or transferred by contact. Since the loss of these low molecular weight components is small during their relatively short usable life, little attention is paid to this commercially. However, in long term storage conditions these compounds, which are frequently organic acids, may be adsorbed by some materials or corrode others. These compounds may be desorbed at later times even after the original object has been removed! Composite polymeric materials in collections may have susceptible components such as magnetic tape (with its information) and may be selectively affected even if the primary component is stable. The monomer remaining from polymerization may also volatilize over time and if acidic may attack other specimens.

Because they respond to changes in moisture and will buffer small spaces, paper collections can change the relative humidity to unacceptably high levels if it has not been previously equilibrated to moderate levels (certainly less than 60% and lower if possible). Under certain circumstances these high RH levels may accelerate certain corrosion processes. If the processed paper, e.g. necessity banknotes, is highly acidic it may affect nearby specimens if not isolated. Banknotes and cardboard jettons or counters may contain acidic components which can alter the longevity of other paper objects or alter the dyes and inks used in them.

Jettons, counters etc. and early photographic components can be nitrocellulose and will give off acidic vapors which can attack most collections. Acetate materials (cellulose acetate or triacetate) will behave in a similar fashion. The acid vapors can be adsorbed by the collections' containers, trays etc. and still be active even after the original offending items have been removed.

Metals are most stable at lower relative humidities and there is no lower limit to the relative humidity at which they can be stored. However, paper and wood should not be at less than 30% RH where the chemical consequences lead to cross-linking of the cellulose polymers. In addition if the materials are restrained in any way, stresses may develop. Stresses produced by moderate changes in RH, about 10% to 15%, will be mechanically safe, that is, reversible. Inked or heavily painted papers may flake or delaminate due to large environmental fluctuations. Relative humidities that are over 70% for any length of time can allow mold growth or other biological attack. Chemically this is also unsuitable.

Collections with adhering mineral accretions from burial or prior corrosion can deliquesce even at moderate RH (60+%) to produce ionic solutions that can accelerate further corrosion.

Collections which are stored in less than ideal conditions should be regularly checked and ventilated with clean air at a suitable RH to remove as much of the potentially harmful vapors as possible.

## EXHIBIT AND STORAGE MATERIALS AND CONSTRUCTION

While externally generated pollution can cause damage to collections, the worst problems occur when materials inside the case are the source of pollutants. Internally generated pollutants can build up to concentrations far above the levels of external pollutants, and usually are not cleared from the case through normal air exchange before they are absorbed by or react with other materials or objects in the case. One of the well known examples is the corrosion of lead by acetic acid released from wood. Lead is converted to lead acetate, which then reacts with carbon dioxide in the air to yield basic lead carbonate and free acetic acid, which can then react further. Very small amounts of acetic acid can react repeatedly to produce considerable amounts of corrosion. The best way to avoid such problems is to use materials that are chemically stable and inert relative to the collections.

Wood is probably one of the most damaging of the materials commonly used in case construction. A hardwood such as oak can release up to 5% of its weight as acetic acid. Softwoods are less damaging, but still not safe. The amount of corrosive vapors released by wood decreases as the wood ages, but even old wood is potentially damaging. Older cases made of wood have been evaluated by placing lead metal coupons in them and watching for signs of corrosion. The use of wood and wood products such as plywood and particle board should be avoided in the construction of new cases. If the use of wood or similar materials cannot be avoided, they can be used outside the object chamber. An interior case can be made from safer materials such as metal and acrylic sheet, and then a wood frame can be constructed exterior to this chamber to give the appearance of a conventional case.

Other construction materials also may damage objects. Some types of adhesives, coatings, textiles, and colorants are known to cause problems, while other types are generally safe. A number of lists of materials that are generally safe or unsafe have been published. Some of the common unsafe materials include: polyvinyl chloride (PVC), nitrocellulose, wool, silk, oil paint, vinyl acetate adhesives, polyurethanes, and sulfur containing materials such as vulcanized rubbers. Some generally safe materials include most acrylics, polyester, nylon, un-sized and un-dyed cotton and linen, polyethylene, glass, ceramics, and many metals (except when contact may cause electrolytic corrosion). Even these materials must be chosen carefully, because additives such as antioxidants, plasticizers, and mold release agents may cause problems. For example, some polyester fiber batting is held together by heating the fibers to melt them together where they touch, while similar batting may be held together with a glue that is not suitable. Other materials are variable enough that the individual product must be evaluated either by testing or by knowledge of its composition. Some silicone caulks release acetic acid when they set and are quite corrosive, while other silicone caulks release only the neutral solvent methanol and are quite safe if ventilated and allowed to thoroughly set before objects are placed nearby. Polystyrene is suitable for use in storage, but is not particularly light stable and its use should be avoided in exhibits.

Off-gassing of formaldehyde, especially by certain types of adhesives previously used in plywood, is less of a problem now because health concerns have led manufacturers to reduce formaldehyde emissions. The phrase *"formaldehyde free"* is used to describe some products, but does not necessarily mean that they are suitable for use in collections. For example, plywood made from formaldehyde free adhesives still releases acetic acid.

The use of pollutant absorbers such as activated charcoal will help to absorb both neutral solvents and acidic vapors. To be effective, a large surface area of activated charcoal must be exposed, and it should be changed on a regular basis.

Paper products used in identifying or storing collections must be of archival quality and not acidic. Acid free or alkaline buffered products are manufactured especially for this purpose. This is not a bad policy for other documents as well.

There are simple methods to test for potential problems from product volatile emissions. The most common is the so-called *"Oddy test"* in which a sample of the material to be evaluated is placed in an airtight inert (glass) container with polished metal coupons (typically silver, lead, and copper). Liquid water should be present, but not touching any of the materials. A similar control specimen with the same coupons but without the test material is also prepared. The containers are placed in an oven at moderate temperature (50-60° Celsius), and the coupons examined after a suitable time, typically several weeks. Excess corrosion in the coupons exposed to the test material compared to the coupons in the blank is attributable to the test material and should preclude the use of the material in exhibit or storage cases.

It is imperative that all materials coming in contact with collections be composed of materials known to be safe or tested for suitability. This is especially true for seldom used collections or those in long term storage. In the present political environment the use of recycled materials has become more desirable if not mandatory. Recycled materials should meet the same stringent criteria.

## THE GENERAL MUSEUM ENVIRONMENT

The obvious general factors which relate to the behavior of numismatic items in storage and exhibition are temperature, relative humidity, light, and air pollutants.

External pollutants such as automotive or industrial emissions are a major problem in many urban museums. Nitrogen and sulfur oxides in conjunction with moisture (humidity) can produce acidic chemicals which will aggressively attack almost all numismatic materials. Hydrocarbon vapors from cars and buses can attack plastic and the sulfur associated with them will also be a problem. The rates of many hydrolytic reactions of paper, plastics, etc. will increase dramatically with increases in RH as the RH rises above 60-70%. This is in addition to increases in rates of the corrosion processes in metals.

Other sources of indoor pollution may be from floor waxes, floor covering strippers, adhesives from rugs, and synthetic fiber rugs themselves. Many cleaning products are mixtures of highly corrosive compounds.

Many materials absorb and desorb water with increasing or decreasing relative humidity. This property can be used to moderate or buffer changes in cases where the average RH in the space exterior to the case is suitable but the overall range is too wide. Cellulose, for example, is a very good RH buffer, and the relative humidity in a case containing significant quantities of paper, books, or matboard will change at a much slower rate and experience less extreme changes than a similar case that does not contain hygroscopic materials. Wood also is an RH buffer, but for reasons discussed above should not be introduced into a case for this purpose. Silica gel is often used to buffer the environment inside cases, and it also absorbs a number of pollutants. Buffers can also be used to maintain an environment different from the exterior of the case, but the inevitable exchange of air between the case and the surroundings means that the buffer must be replaced on a regular basis as indicated by monitoring of the RH in the case interior. For example, silica gel in a case can be regularly replaced with pre-dried silica gel to maintain an RH lower than that in the ambient environment.

Plastics have a more limited moisture buffering capacity which means that the RH of the air surrounding the collection will depend upon the initial RH and the exchange of air with the external environment. Metals do not have this capacity at all but often are coated in some fashion and these coatings can be a problem if they off-gas or decompose.

Relative humidity is an important factor in the preservation of collections, the exhibits and storage cabinets, and the museum building itself. High RH in cold climates can lead to water condensation in the walls and cause deterioration of the building. High RH, about 70%, in most regions can also lead to mold growth. Because of the large size of most exhibits and cabinets, rapid changes in RH within a moderate range (35-55%) have little effect.

Temperature will be a problem only if it is too high. The rate of most chemical reactions decreases as the temperature drops and increases as the temperature increases. Typically museums in the United States are maintained in the range 19 to 22° Celsius. What is important is that in some areas the temperature may be lowered in winter to about 10° Celsius without damage. This is, of course, in storage areas and not in the general museum exhibit area. With metal corrosion though, there may be a tradeoff between lower reaction rates in the cold but lower RH at higher temperatures. In a closed system the RH drops as the temperature is raised. Non-metals are almost certainly going to be at risk at high temperature even if the metal objects are stable.

## SELECTED REFERENCES

ERHARDT, D. AND MECKLENBURG, M. F., *Relative Humidity Re-Examined,* in IIC Ottawa Congress (Sept. 1994), pp.32-38

ERHARDT, D., MECKLENBURG, M. F., TUMOSA, C. S. & MCCORMICK-GOODHART, M., "The Determination of Appropriate Museum Environments", in *British Museum Occasional Paper* 116 (1997), pp.153-163

GREEN, L, *The Storage of Coins and Medals,* The British Museum, Dept. of Conservation (1990), pp.1-4

GREEN, L. R. & THICKETT, D., "Testing Materials for Use in the Storage and Display of Antiquities - A Revised Methodology", in *Studies in Conservation* 40.3 (1995), pp.145-152

MECKLENBURG, M. F. & TUMOSA, C. S., "Temperature and Relative Humidity Effects on the Mechanical and Chemical Stability of Collections", ASHRAE *Journal* (1999), pp.77-82

ODDY, W. A., *The Corrosion of Metals on Display,* in IIC Stockholm Congress (1975), pp.235-237

PADFIELD, T., ERHARDT, D. & HOPWOOD, W., *Trouble in Store,* in IIC Washington Congress (Sept. 1982), pp.24-27