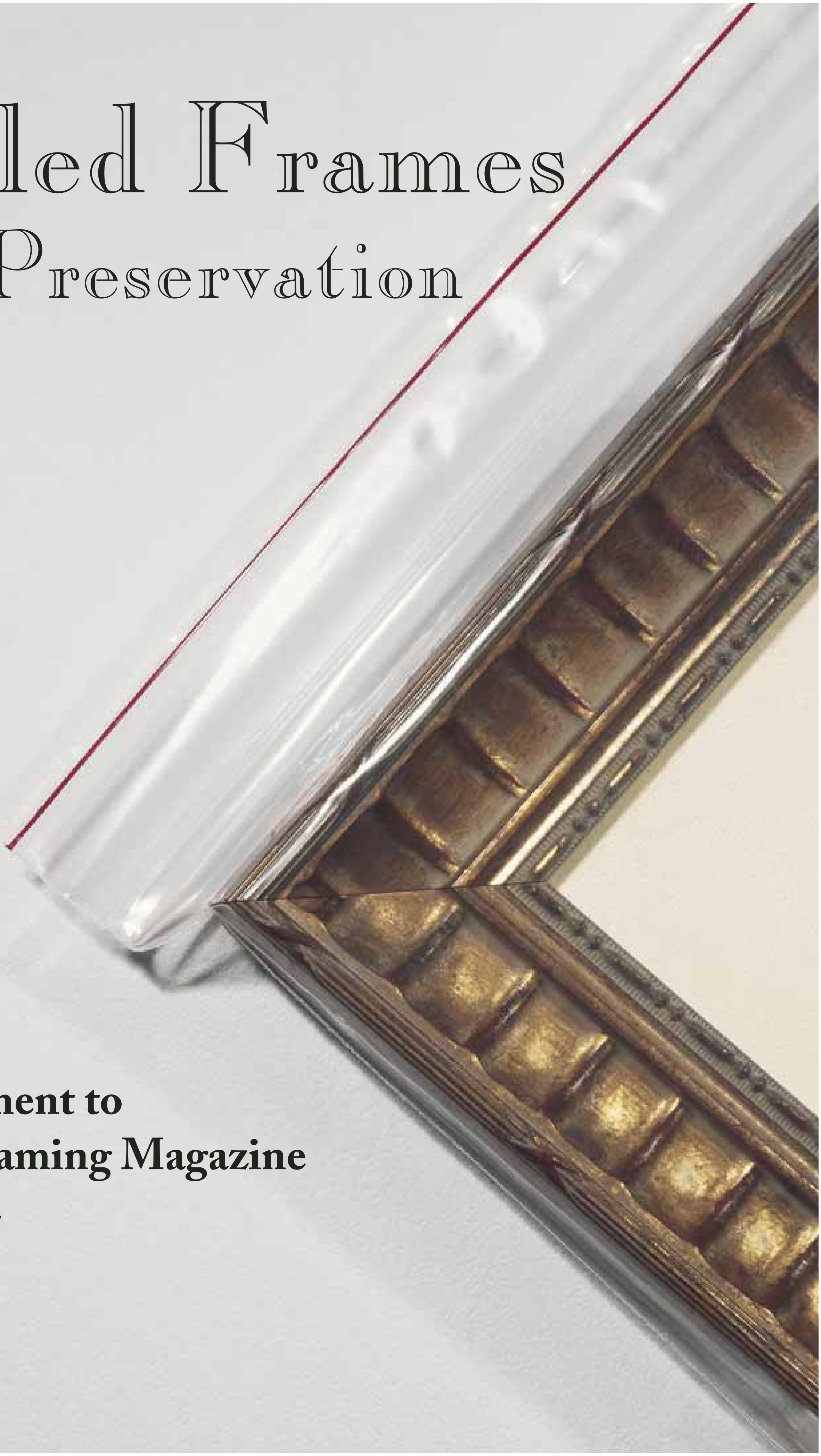
Sealed Frames For Preservation



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by Hugh Phibbs

SEALED Frames for Preservation

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Introduction

The terms "preservation" and "framing" fit together uneasily. Works on paper, fabric, or animal skin can best be preserved if they are stored in a dark, stable, safe environment. Framing is a form of display and as long as a frame is on view, its contents are exposed to light. Even with the ultraviolet wavelengths filtered out, light will cause change in these materials. The decision to house something in a frame must be made with the knowledge of the effects that long term exposure to light will have on that item.

The frame can provide invaluable protection for its contents against mishandling and physical accidents. If it is properly designed, it can shield its contents from physical and chemical pollution and from the effects of fluctuating and extremes of relative humidity. These last features have become more widely available in the last decade as designs for highly sealed packages have been developed to enhance the role of well-designed frames as useful preservation tools.

The most important element in highly sealed framing is laminated sealing film. This material has been used for decades in military applications and food and medical packaging. Many types comprise an inner, bonding layer of polyethylene, an aluminum layer that serves as a vapor barrier, a second layer of polyethylene that bonds the aluminum to the outer, puncture-resistant layer of plastic, and the outer layer. The outer layer may be made of polypropylene, polyamide, or polyester. Each of these polymers has a melting point that is higher than that of polyethylene and allows for heat bonding of the inner layer, while the outer layer remains intact.

These films can be used to isolate wooden elements, such as fillets or frame rabbet edges, from the contents of the frame. If a sheet of one of these films is substituted for the dust cover paper on the back of the frame, it can isolate the contents of the frame from dampness that may come from the wall behind it without the creation of a highly sealed package in the frame. Finally, they can also be used to create packages that seal in the proper conditions to which the matting and the framed item have been acclimated and can maintain those conditions indefinitely, if vapor-barrier glazing is used.

Glass is crystalline enough to function as a vapor-barrier, and if it is used in a laminate, with two lites of glass bonded together or with glass outside of acrylic sheet, it will provide both safety and a barrier to the passage of moisture. Acrylic sheet has less vapor-barrier potential and it will warp if its sides are exposed to differing levels of relative humidity. This means that the break-resistant safety it offers must be weighed against the possibility that sealed packages glazed with it can loose their initial conditioning, eventually. If such a package is kept in a climate with conditions drier than those in the package, it will warp in toward the art.

When the framed work will be kept in an environment that has stable, non-extreme condition and it must be protected from water that might come from an accident with a sprinkler system, it can be sealed in a package glazed with acrylic sheet. Glass is needed for packages that will be exposed to fluctuating or extreme exterior condition and when static on the glazing might pose a problem.

The last decade has seen the development of packages sealed with heat and either double-sided pressure-sensitive tape or electrical-grade hot melt glue. Designs have evolved to accommodate both matted works and works that have the form of paintings on either stretched canvas or on panel. These developments and techniques have been described as they have come into service and are gathered, here, into the first complete overview of this topic.

Some Cautions with Relative Humidty

Fears about unintentionally creating overly damp conditions in the mat package make many framers shy away from truly sealing frames. The vision of mold growing inside a frame or foxing occurring on the matting can easily give one pause, and framers should be applauded for their caution. The questions surrounding relative humidity (RH) are not, however, as arcane as they might appear.

Extremely dry conditions are a grave threat to wood and wood laminates, ivory, hides, horn, bone, many paint films, and glue layers. As such materials become desiccated, they can crack and change shape; paper becomes brittle and more fragile.

When can such conditions be expected? Land areas which are far from sources of airborne water have dry climates. The high plains of our Rocky Mountain region experiences conditions of relative humidity which may hover around 20% annually. Collectors in that region would do well to focus on items made of metal and to avoid leather, wood, and the like.

When a residence is heated, air from the furnace will be desiccated. Even an effective humidification unit will be hard pressed to keep the relative humidity in the home at 50% at 70°F. Air which is that humid may condense on the inside of the windows of the home or its exterior walls.

An item in an unsealed frame in a home will likely go through a dry phase during the winter. Since most framed materials are not overly sensitive to dry conditions, this is usually not a problem.

A dry phase will probably not occur in areas which do not have significant amounts of heated air in the winter. In Hawaii or southern Florida, for instance, a frame may be in relatively damp conditions year round. Here, the framed item is in constant peril of foxing or mold growth. When relative humidity exceeds 65% at 70°F, mold may begin to grow.

The germinal parts, commonly called spores, are actually conidia. They are airborne and can be found on most surfaces which have been exposed to the air. As the moisture available to them increases, they can begin to send rootlike filaments into organic materials such as paper, wood, or hide. They extract nutrients and produce more fruiting bodies which can be seen on the surface of the infested material. If relative humidity is lowered, their destructive growth is arrested but potential for future growth remains.

In the past, antifungal materials were used to address this problem. Thymol is the most common of these. However, many fungicides tend to discolor the paper to which they have been applied when exposed to light for a period of time. These fungicidal materials are also highly volatile and cannot be expected to protect treated materials from future infestations.

Ultimately, the simplest answer to the problem of mold and mildew is to avoid damp conditions. To accomplish this, one must appreciate the varied sources of high relative humidity.

Those who live very close to the ocean and other salt water bodies are affected not only by the moisture, but also from salt which is borne inland as an atmospheric aerosol. Metals will be very difficult to maintain here. Other items should be given as much protection as possible.

In the U.S., most residents will be affected by damp stretches of weather during at least part of the year. Air conditioning is a first line of defense. Room dehumidifiers are often designed with a bucket to collect condensation. This would be impractical with an air conditioner, since it draws so much water from the air that emptying its bucket would be constant. Most homes with central air conditioning will have conditions drier than mold requires.

Even homes with window units are usually not very moist for long periods, since clothing and fabric on the back sides furniture would begin to mold if they were. Mold requires still air to grow, so air movement will discourage growth on open surfaces. Trapped air may be a factor in the growth of mold, but architectural moisture is probably a greater cause.

Exterior building walls without a vapor barrier layer will allow moisture through and into the room. This is true of older construction and of masonry walls. If moisture comes through the wall into the back of the frame, it may become trapped, making the relative humidity in the frame higher than that of the room.

This may be what is happening in the case of clients who bring in works with mold from homes with well-controlled climates. Interior walls which connect with attic or crawl spaces and are open to outside air may present the same problem.

Sealing the mat/glass package can defend against both very wet or dry conditions, but the framer must be familiar with proper sealing techniques, as well as with management of condition in the shop. This way, the contents will be properly conditioned before the seal is made.

Keeping the relative humidity in a frame shop within a safe range may be easier than it first sounds. If one considers how often items in the shop have grown mold, or how many have shown signs of new foxing, one will have an idea of how often the relative humidity has been dangerously high for a long enough period to cause damage. Even if the shop is briefly exposed to dangerously high conditions (due to power failure in the summer, or flooding), the endangered materials can be moved to a safer place or sequestered in vapor barrier materials before they become damp.

Looking at the other side of the humidity issue, materials which will suffer from exposure to low relative humidity—wooden panels and inlay, ivory, oil paintings with hide glue grounds, and thick layers of gum in watercolor and gouache—are not frequently brought in for framing. When such an item is brought in during a dry period, it can be kept in a vapor barrier bag with a conditioned blotter or board until it is framed.

To understand and control relative humidity one must first be able to watch it change. The least expensive monitor for relative humidity is a cobalt salt card. A pack of five of these cards can be found in most preservation supply catalogues for less than $10. If these cards are fixed to a wall in each room of the shop and to the inside of storage units (such as map drawers), the staff can begin to get a sense of how the conditions fluctuate in each area over a year. An electronic hygrometer will also be useful in tracking the conditions of the air in the shop and will provide a check on the cards.

Tracking the changes shown by the cards is likely to reveal that the shop will be on the dry side of 50% far more often than it is on the damp side, unless it is located in a basement. Each building has areas of greater and lesser fluctuation in relative humidity. Exterior walls are an obvious source for concern.

Furthermore, few buildings are designed with vapor barriers in their walls. Plastic sheeting can slow the passage of water vapor, but an additional layer of metal foil is required for complete vapor barrier protection. Since there is little likelihood that any outside walls in the shop can be expected to have complete vapor barriers in them, critical functions such as art and board storage should not be adjacent to these walls.

Interior walls must also be examined to see whether they communicate with attic or crawl spaces which have untreated air in them. Warm, damp air in the summer can move into such walls and humidify them. In the winter, cold air moving through such walls can lower their temperature and make them condensation sites if the room air has been humidified.

In light of these considerations, the simplest strategy is a concentration on local control of humidity. Concentrating on the areas where the matting materials and works to be framed are stored allows relatively small effort to produce significant results. The storage drawers can be shielded with vapor barrier film (an aluminum/plastic laminate) which encloses the bottom, back, top, and sides. They will be open to the air in the room, but this can be tracked. It is also possible to make large pouches which will fit into the drawers themselves. The pouches can be fashioned by ironing the laminate to itself. If separate side pieces are used, it will accommodate larger loads.

When materials are added to the system, attention should be paid to the amount of moisture which they contain. If a paper-based item has come in from an automobile on a damp day, it can be placed in a clear polyethylene bag with a cobalt salt card and watched for an hour or so. Anything to which hinges have been attached should also be kept out of the drawers until it is thoroughly dry. The same is true for any board which comes into the shop, especially if it has been delivered during a time when the weather is damp.

Basic Frame Sealing

There are a number of factors which must be considered in the context of frame sealing. What is being sealed in and what is being sealed out? How long can the seal be expected to last? How effective will the seal be under different conditions? How difficult and expensive will it be to establish various levels of sealing of the package? How much benefit can be expected from a sealed package?

The materials which are to be sealed in a package with a work of art on paper should be as well known—and, therefore, as simple—as possible. The fewer the variables that are included, the fewer chances there are for an unanticipated problem. If the components have been proven over long periods of time to have no adverse effect on delicate art which has been stored in proximity to them, they should work well in the future. Boards and hinging materials made of pure cellulose will be chemically similar to the paper on which the art has been done, as will vegetable starch hinging paste which, like paper, is a polysaccharide. Synthetic glues have a less proven track record than animal and vegetable glues and pastes, but the best of the synthetics certainly seem to be stable and relatively inert.

The inclusion of plasticizers and tackifiers in pressure-sensitive adhesives raises more questions. These additives are often not chemically linked to the material which they are modifying. A plasticizer, for instance, can keep a material supple by holding its molecular structure apart so linkages, which would create more rigidity, cannot form. This sort of material may migrate out of the substance to which it was added. This could be especially troublesome if it migrated out into a closed environment.

One question to ask in designing a package which will house something valuable and especially a package which is to be sealed, is: Do any of the materials to be used have an odor? The human nose may not be as acute as that of other mammals, but it can detect a vast array of off-gassing molecules. Some things like hinging paste may have a benign odor, but a tape which smells of vinegar is probably emitting acetic acid. If the materials to be used inside the package have been determined to be stable and inert, the next question involves the nature of the seal and what it will exclude.

Different materials can be used to seal out particulate and gaseous pollution, humidity, and light. Nothing can give long term insulation from changes in temperature, so the effect of these changes on the materials and on the design of the package must be considered. No package containing any materials which are conditioned to higher than accepted relative humidity conditions can be safely sealed. Indeed, since packages which contain glazing will transmit water vapor through their glazing, having the materials to be sealed slightly on the dry side will permit a greater margin for safety. The accepted conditions referred to here are 50% RH at 70°F or roughly 20°C.

Most art on paper will do well in somewhat dryer conditions than these, but extreme drying will cause the paper to become brittle and will cause paint films and emulsions to crack. If a package with damp components is sealed, the relative humidity can rise as it cools and cross the threshold at which fungal growth can occur (namely, 65 to 70%). A damp package may also experience condensation if it is suddenly illuminated strongly and the paper products and air within warm up more rapidly than the glazing.

Excess humidity must never be sealed in. The only true barrier to humidity is a metal film. Most coatings and plastics sheets and boards will permit the passage of water and other vapors. The exact rate of this transmission is too complicated a question to be factored in to the design of a framing package, but it can be said that the thicker the material, the slower and less efficient its transmission.

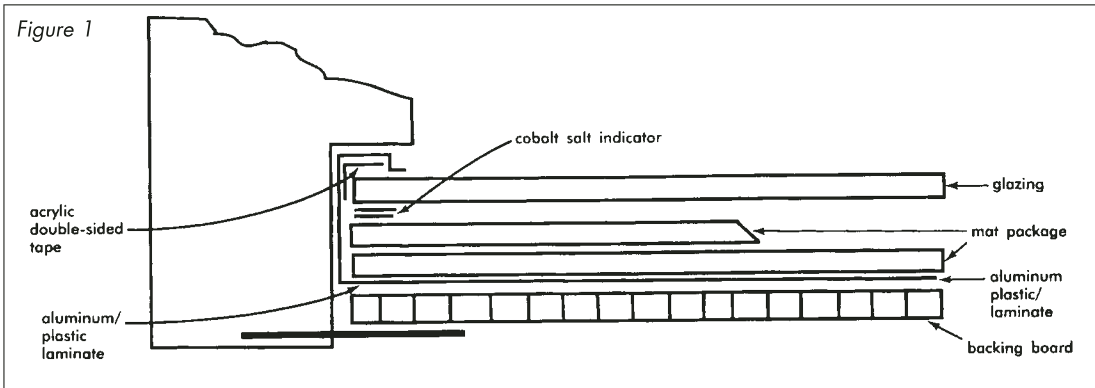
While much of the gaseous pollution which comes from our atmosphere will be sealed out by a plastic barrier, a sacrificial metal scavenger (such as active copper) or molecular sieve is needed to give such a layer the kind of efficacy which approaches that of a metal foil. Since the metal foil will stop the passage of water vapor, it can not be safely used in framing unless the materials and environment involved in constructing the frame can be guaranteed to be conditioned in the proper range. If this can not be provided, the sealing out of pollution may be effected through the use of the plastic barrier and may be enhanced by the addition of the scavenging material while water vapor is allowed to enter and leave at a reduced rate.

Briefly stated, the technique of basic frame sealing comprises surrounding the properly conditioned matting materials and the art which they house with a solid sheet of aluminum/plastic laminate (such as MarvelSeal 360 or 470, or Mitsubishi PE/AL/PE/PET). The sheet of laminate is pulled around the sides of the mat package and secured to the side and the front of a sheet of acrylic or laminated glass. A double-sided pressure-sensitive tape is used to bond the matte, polyethylene side of the film to the front and edges of the glazing. If a window mat is used the film can be further fused to the tape with heat provided by a household or tacking iron set on medium high. The wrinkling of the film will reveal the establishment of the bond. If a window mat is not used and the art comes within an inch or less of the edge, the laminate should be reversed so that its shiny, nylon side will be inside, as this will give a much superior cold bond to the acrylic tape. In both cases, the excess film should be trimmed off using the same technique employed for trimming the backing paper on picture frames.

Environments in which brief, unavoidable periods of high relative humidity occur can be protected against by such packaging. This package will eventually absorb dangerous amounts of moisture if left in constantly high conditions and can not be used unless there will be an alteration of high and low relative humidity. This highly sealed package is only one among many options which can be employed to shelter framed art work from environmental harm.

Pressure sensitive tapes are frequently used by framers to seal the edges of the glazing in a frame. If the tape is applied between the edge of glazing and the rabbet, it may serve to keep dust from coming under the lip of the frame for a time. There is, however, not much dust which will enter through this route if the frame has a smooth, flat lip. The grip of the tape on the frame will eventually give up.

Figure 1



This package will have relatively high resistance to the influx of water vapor. That resistance can be multiplied by the inclusion of properly conditioned silica gel impregnated paper. This material has many times the capacity of paper to absorb and release moisture and it can buffer the contents of such a sealed package against transmission of water vapor though the glazing for much longer periods. A strip of cobalt salt humidity indicator card can be placed under the edge of the glazing, and on top of the edge of the window mat, so that it will hide from all but the most inquisitive eyes under the lip of the frame [Figure 1]. This will permit the owner, who has been briefed as to what to look for, to monitor the condition inside the package periodically.

A more common practice is the application of tape to the edges of the glazing in the front of the package and around to the edges of the backing board in the rear. This leaves the adhesive coated side of the tape pointed in toward the interior of the package and the art it contains. As the tape ages its volitiles can infuse into the package with potentially undesirable results. This problem can be overcome by facing the inside of the tape with an impervious barrier.

One simple candidate is the plastic/aluminum sheet. This material comes in long rolls which can be cut into small segments on a power miter box to produce small rolls of whatever thickness is needed to face the part of the pressure-sensitive tape which will extend around the side of the mat [Figure 2]. This can be applied by running the tape along the face of the glass and leaving it extended from that edge while the laminate is applied to the extended portion [Figure 3]. If the polyethylene side is applied to the adhesive on the tape, it will be easier to reposition if it goes astray and the inert nylon side will face in toward the art. Other materials such as rolled polyester sheet can be used to perform this role but their barrier potential is not as great.

Any pressure-sensitive tape which is used to seal a frame will loose its hold as it ages. The more its adhesive is protected from oxygen and oxidizing gases, the longer it will maintain its bond strength. This is one the purposes in sheltering the adhesive inside the laminate in the highly sealed package described here. The material to which the tape is applied must also be considered in assessing the longevity of the tape bond. Tape stuck to metal will be sheltered by that metal and tape suck to glazing and plastic boards will also be somewhat sheltered by those materials. Aging gases can still permeate the carrier of the tape itself or penetrate from its edges, but this will be significantly less than the amount which can be expected to come through a paper board or wood.

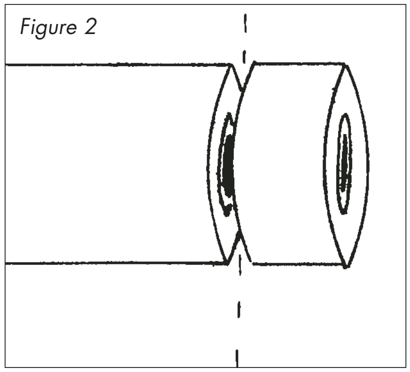
Tapes with poor quality rubber family adhesives can be expected to oxidize and release their hold sooner than acrylic family adhesives. Tapes are not the most physically rugged method of creating a seal, but the use of gasketing and pressure sealing requires so much support structure and expense that it is not yet practical for use in commercial framing.

Advanced Frame Sealing

This basic method just explained will perform well as a barrier to relative humidity and can be quite useful for the normal range of conditions which a frame can be expected to encounter.

A weak point in that design is its use of pressure-sensitive adhesive. This material can fail if the pressure inside the package exceeds the pressure outside of it. That can be the case if the package experiences a change in altitude. The seams of the package at its corners are also a weak point. Where one layer of tape crosses another, small gaps will occur which cannot be flattened by the application of heat. This can be demonstrated by placing such a package under water and applying pressure. Small bubbles issuing from these corner sites are evidence of this problem.

Figure 2



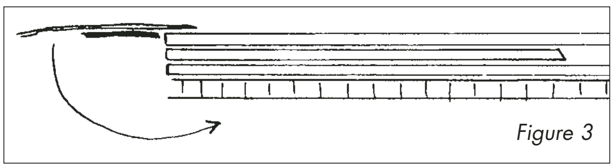


Figure 3

More durable packages can be made if an electrical-grade hot melt adhesive (such as 3M 3797 or 3748) is substituted for the pressure-sensitive tape. The best of these adhesives are made of polyethylene and or polypropylene. Those made of polyvinyl acetate or ethylene vinyl acetate can be expected to give off acetic acid in time. The better hot melt adhesives need a high temperature, industrial quality gun for application. This higher temperature allows the glue to bond more successfully to other polymers.

Before the glue is applied, the edges of the glazing sheet must be dulled so that they will not cut through the laminate. If a package is to be made using acrylic sheet as its glazing, it will allow gases to enter and exit through the acrylic. This type of package can work well in situations in which the climate may fluctuate but will not maintain high or low RH conditions over time. If a package is to be placed in an environment which has high or low relative humidity consistently over long periods of time, glass should be substituted for the acrylic glazing.

When a package is made using acrylic sheet, the edges of the production paper can be peeled back along the edges and folded over onto themselves. This will expose the edge of the sheet while it protects the rest and will lift the straightedge up off the surface so that it does not become stuck in the hot glue. The glue should be extruded onto the edges with the same technique used for caulking. The glue is pushed out in front of the nozzle. After the glue has been extruded along one edge, the sheet should be turned so that it can next be set on the opposite edge. When both of those lines of glue are cool, it can be applied to the remaining two sides. Using this pattern reduces the possibility that the straight edge will become fouled in still warm glue.

If glass is required for a sealed package, it should be laminated or used in combination with acrylic sheet. If a package were made with unlaminated glass and it simply cracked, there might be an extended interval in which the inside of the package slowly changed its conditioning. This is because the sides of a crack in a lite of glass are so close together that water vapor can not move through rapidly. If the glass broke and pieces dislodged, the package could loose its conditioning quite rapidly.

Before the glue is applied to the edges of the glass, they should be washed with alcohol to remove any greasy residue which might disable the bond. The bond which the hot melt makes to the surface of glass is less adhesive than that which it makes to the surface of acrylic sheet. The temperature of the hot melt is high enough that it can bond readily with the acrylic, but this is not the case with glass. Lines of glue must be applied to the edges of the lite of glass on both sides. This permits the laminate, which will form the skin of the package, to be secured to both sides of the glass and then bonded to itself just outside the edge of the glass, creating a more durable seal [Figure 4].

The heat needed for the creation of these packages will be the same as was required when double-sided tape was employed: roughly three quarters of the maximum heat which most tacking irons will provide. To find the proper setting, one should practice bonding the laminate to itself and to cooled extruded hot melt. When the silver surface of the laminate film has acquired a wrinkled appearance, it has reached bonding temperature. If it maintains a smooth surface, the bond may be suspect. The film should always be bonded to other materials or to itself using the matte, polyethylene side as the bonding surface. The shiny, nylon side will be the side which faces the outside of the package.

Since the adhesive used here is more difficult to apply and bond in a controlled manner than was the case with double-sided tape, the frame may need to be chosen or modified accordingly. The lip or rabbet width of the frame should be no less than 3/8", and wider dimensions will help. The allowance between the edges of the glass and the sides of the rabbet should be roughly 1/8" at each edge and 1/4" when considered together. If a frame which has these dimensions cannot be found, it may be possible to use decorative wooden fillet material to extend the lip or rabbet width of a frame which is available.

There are two basic designs for highly sealed packages, one for matted works on paper and one for paintings. When either type of work is being sealed, its condition and the condition of the materials which will be sealed with it must be established as being in an appropriate range. This can be done with nothing more expensive than a cobalt salt indicator card which has been enclosed in a plastic bag

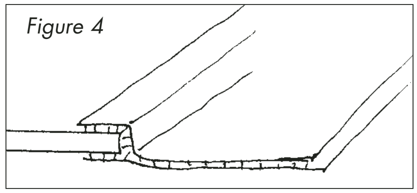


Figure 4

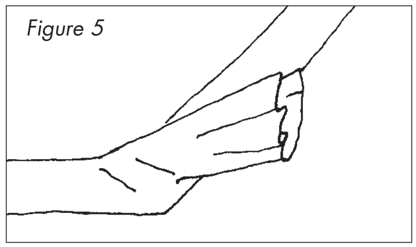


Figure 5

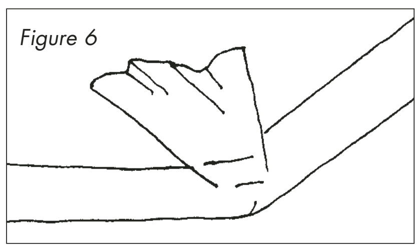


Figure 6

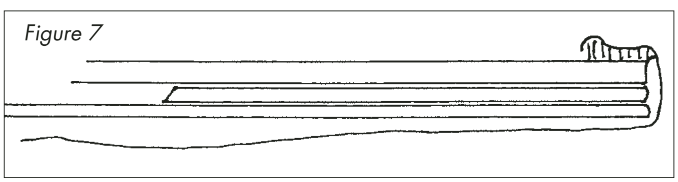


Figure 7

along with the material in question for a few hours. Everything which will be inside the package must be conditioned to 50% RH at 70°F.

If conditions with more humidity are permitted, there may be circumstances in which changes of temperature will cause the relative humidity to move into a dangerous range. When a window mat package for a work of art on paper is sealed, the only air inside will be that which is between the fibers of both the board and the art, and that which is in the opening of the window. The mass of cellulose in the mat and the art will readily condition that small quantity of air. As the temperature of the package drops and the air can hold less moisture, the cellulose will absorb that moisture. When the temperature in the package rises, the air will be able to hold more moisture, which the cellulose will contribute to it. The relatively high proportion of cellulose to air in this type of package means that there should never be a problem if the materials are conditioned.

When a painting is enclosed, there will be more air in the package. The spacer which holds the painting away from the surface of the glazing will create an air space, as will the hollow in back of the painting between the sides of the stretcher. The wood of the stretcher will form a highly efficient reservoir to buffer conditions inside of the package, and stretched canvases are less sensitive to fluctuations in RH than works of art on paper.

A painting on a wooden panel of the antique variety, however, can be quite sensitive as it expands across its grain. These are not frequently found in the work stream of frame shops, and if one were brought in with the request that it be sealed, a conservator should be consulted. Pressed and laminated wood panels are not so reactive, and can therefore be regarded as being more similar to stretched canvases.

If more condition buffering is needed, paper impregnated with silica gel can be obtained from conservation suppliers. This material is a very efficient reservoir for water vapor. It works because it has an extensive surface area to which these polar molecules will loosely bond. Since the silica get is many times more effective than paper as an RH reservoir, its proper conditioning is critical, and that condition must be checked before it is sealed in a package.

When the package for matted works is begun, the mat package is laid on a sheet of plastic/aluminum laminate which is roughly 1" larger than the mat in every dimension. The glazing, to which the hot melt glue has been applied, is cleaned and fitted onto the front of the mat package. When all dust has been eliminated, the laminate can be tacked to the hot melt. This is done by puffing it up and over the glue and applying enough heat to fuse it to the glue. At this point, the line of glue will not have been flattened.

The heating proceeds along each side toward the corners. The bonding of the laminate to the corners is the most important part of the sealing process, since it is here that leaks are most likely to occur. The laminate which has been bonded to contiguous edges will form a group of gathers at the corner. This should be puffed together and pulled toward one of the sides so that heat can be delivered to its base [Figure 5]. This material should then be pulled over toward the other adjacent side and heat applied to its base on that side. Finally, the material can be puffed over toward a line which bisects the angle which the corner forms and heat can be delivered to the center of the base of this gathered portion of laminate. It can then be flattened [Figure 6]. The purpose of this elaborate heating of the corner of the package is insuring that this folded part of the package does not have any remaining gaps.

When the corners have been treated, heat should be carefully applied to the edges so that the hot melt under the laminate is flattened and a firm bond is established all around the package. One sign that the seal is good in a particular area is the oozing of the hot melt from under the edge of the laminate toward the center of the acrylic glazing. When the bonding is complete and the hot melt is cool, the laminate can be trimmed using the same technique one would use to trim the paper on the back of a frame. The finished edge should look like Figure 7 in cross section. This sort of sealing should be practiced, and the practice packages should have a compressible material in them so that they can be squeezed to test whether the seal has been achieved. A properly sealed package will not collapse when squeezed and when more than one has been made during practice, production can begin.

This package can be made waterproof and may be useful if an item is to be hung in a public place where it may encounter water from a sprinkler system. Since the acrylic glazing will permit a minute amount of water vapor to pass through it, such a package can not be left in high humidity for indefinite periods. Glass can serve as an effective vapor barrier

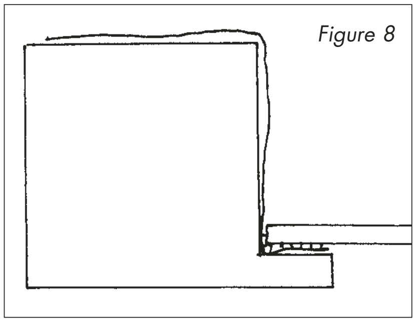


Figure 8

and can be used to make packages which will maintain their proper initial conditioning, but a more complicated package and laminated glass must be used.

This type of package uses two separate strips of plastic/aluminum laminate for each edge of the glass. One strip will extend from the front edge of the glass, across the depth of the rabbet, and on to the back of the frame, where it will form a bonding surface [Figure 8]. The other strip will be narrower and will go from the inside edge of the glass and extend up the depth of the rabbet, but no further [Figure 9]. The wider strip is heat bonded onto the hot melt glue layer which has been applied to the front side of the glazing along each edge. These strips should overlap their neighbors at the corners [Figure 10].

Their bonding is done in the same manner as was done with the acrylic sheet, with the strips first tacked in place and then pressed down onto a flattened glue mass with more heat. A problem which may be encountered here is that the capacity which glass has for retaining heat will make the laminate film easy to dislodge for a longer time than is the case with acrylic sheet. Thus, when the second application of heat is provided, care must be taken that the tacking iron does not twist or otherwise dislodge the film. The overlapping portion of the strips at the corners should be drawn up so that their matte polyethylene sides face each other and are aligned [Figure 11].

The sides are joined to each other with heat beginning at the overlap of the edge of the glass and proceeding

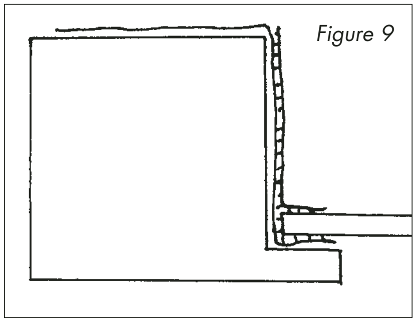


Figure 9

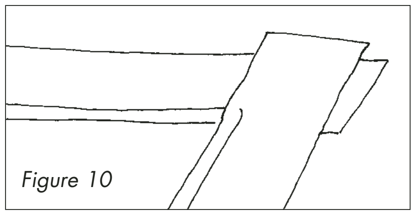


Figure 10

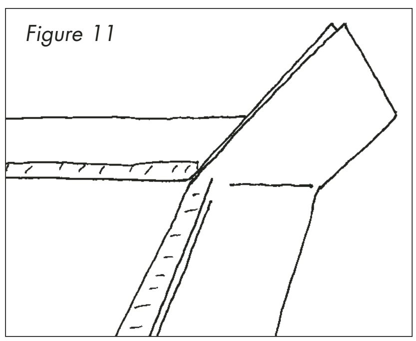


Figure 11

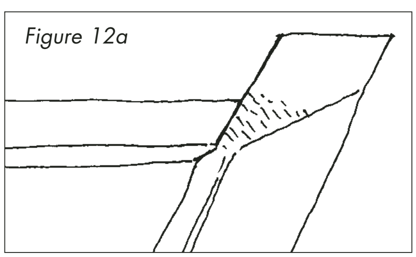


Figure 12a

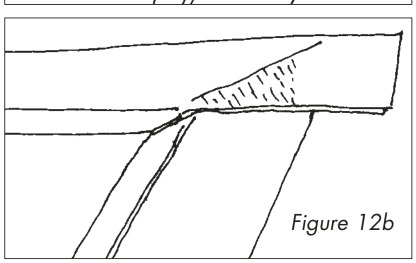


Figure 12b

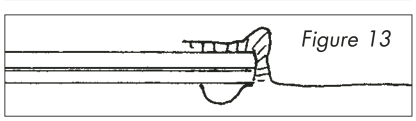


Figure 13

along the length of this intersection. This will create a flap which should be heated on both sides to ensure that it is fully bonded [Figure 12]. The joined edges of the material at the corners should be bonded to the hot melt glue on the front of the glass with special care to guard against the possibility of remaining gaps. When the bonding of the laminate to the front of the glazing is complete and the corners have been completed, heat should be applied to the laminate where it passes over the sides of the glass. The hot melt will likely have extended slightly over the edges of the glass, and this step will bond the laminate more thoroughly and will produce an edge which can be completed more easily. When this application of heat has been finished, the front edge of the laminate may show a ridge at its front outside edge which will be a sign of good adhesion [Figure 13].

The glass can now be turned over and narrower strips of the laminate can be prepared. These should be cut in lengths equal to the dimensions of the edges of the glass. A strip of board, equal in thickness to the package, should be cut so that it can be used as a bonding support. The narrow strips can now be heat bonded to the hot melt on the inside of the glass and to the inside of the wider strips [Figure 14]. There will now be a nylon surface which lines the inside of the package in all but the four corner areas. The package will look like Figure 15 in cross-section.

The remaining polyethylene surfaces can be joined to their neighbors with heat if the package is stood on edge and heat is applied to the outside of each corner [Figure 16]. This will create a package which has tough walls

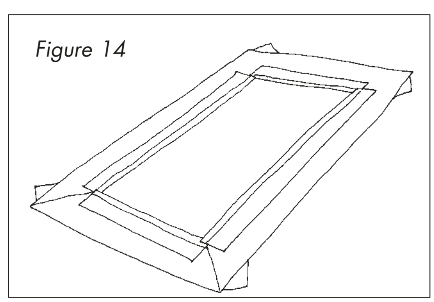
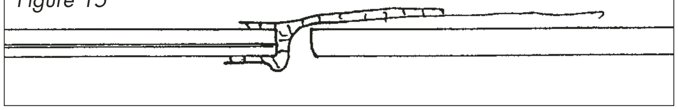


Figure 14

and will fit into the frame. The corner flaps should be wrapped around the corners so that it can be set in the frame and the outer portion of the wider strips folded onto the back of the frame [Figure 17]. If the bonded strips at the corners do not lie comfortably on the back of the frame, they can be released from one another with heat which has been applied to their outside surfaces so that the inside surfaces can be gently pulled apart. Double-sided tape can be placed on the back of the frame so that it holds the laminate in place during the next steps.

Figure 15

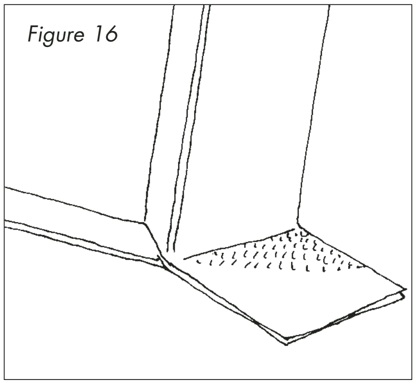


This sort of package is useful with anything which must be enclosed which does not have a window mat to remove the edges of the work from the heat needed to create the seal of the package. The sealing done with this package takes place on the back of the frame and thus, away from its contents. The spacer which will be used to keep the work away from the glazing can now be installed on the edges of the glazing.

In the case of paintings, the spacer can be made of strips of radiation cross-linked polyethylene foam which have been cut to the proper width and secured with acrylic double-sided tape to the glazing after it has been given a final cleaning. The painting can now be installed and shimmied into place with more strips of the polyethylene foam. If silica gel is used, openings should be left in the shims around the edges of the painting so that the air in front of the painting can be affected by the silica gel in back.

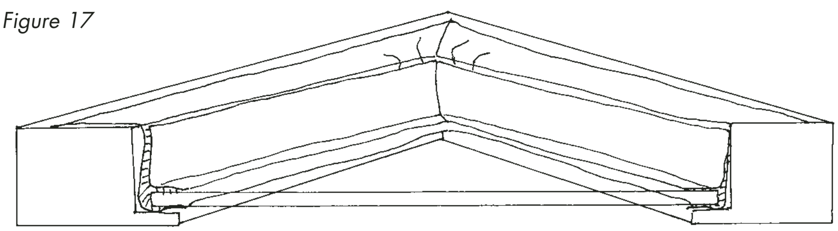
The package can now be closed with a sheet of plastic/aluminum laminate. This is cut so that it is larger than the back of the frame and is laid with the polyethylene side down over the frame and its contents. It is bonded with heat to the portion of the strips which extend onto the back of the frame. The heating should produce the wrinkled appearance indicative of a complete bond. More time should be spent on the corners where the material on the bottom will have folds in it. These areas should be given enough heat so that the folds are flattened .

Figure 16



When the these seams are cool, their edges can be trimmed off inside the outside edge of the frame, just as if they were the edges of a sheet of backing paper. The painting can now be secured in the package with padded mending plates which are screwed into the back of the frame through the bonded portion of the package. The plates should be bent to give them the proper shape and their ends, which will press on the painting, should be given pads of polyethylene foam held in place with double-sided tape. When the plates have been screwed in, a sheet of

Figure 17



polypropylene double-wall board can be cut so that it is slightly smaller than the back of the frame and can be secured to the frame with screws through the bonded portion of the laminate [Figure 18].

This sort of package can also be used with acrylic sheet glazing when paintings are being framed. If a thicker type of sheet is used, it will give greater resistance to the influx of water vapor and will allow for more ready adhesion of the laminate to the edges of the sheet. Whether glass or acrylic sheet is used, the double thick walls of this package give it a greater resistance to punctures, therefore it will endure more handling than the package designed for matted works and will hold a heavier load.

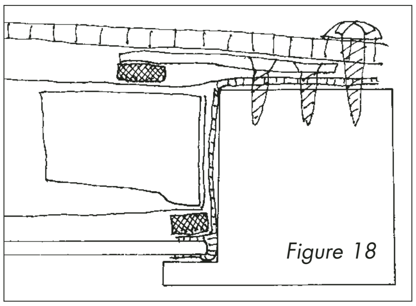


Figure 18

The backing board must be behind both types of packages to reduce the possibility of punctures. An RH monitor can be included in either type of package. This can be done if a cobalt salt card is cut so that a narrow strip of it can be secured inside the package. It should be placed in an unobtrusive site under the lip of the frame so that it can only be seen if special care is taken and will not be visible to the casual viewer [Figure 19].

The need for proper conditioning of the material inside the package cannot be overstated. It is also unwise to seal in materials which may have self-destructive potential. Obviously, such materials would not be included in the housing around the art, but when the art itself is made of such materials, especially those which produce acids which can build up over time, some provision for the uptake of the acid should be made. This may be done with the use of scavenging materials, but there is no way of knowing how these materials are functioning in the enclosure. A less sealed environment, which allows for off gassing beyond the frame, is probably wise.

Placing Potential Damaging Items in a Sealed Frame

When clients insist on housing materials in a single frame which may affect one another chemically, the accommodations the framer should make for these materials should be tailored to suit the gases each item emits. Woods and some plastics give off acids and peroxides, other plastics give off chlorine, rubber gives off sulfur, and oxidizing metals can contaminate other items that are in contact with them. Each of these materials must be isolated from other items in the frame, but some of them may even need to be ventilated to the outside of the frame to slow their self-destructive potential.

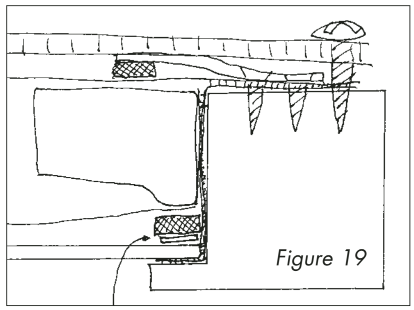


Figure 19

Glass and coated metals are the essential constituents of isolation in framing. When an isolation package is made with glass and metal/plastic laminate, it can be secured in the frame behind a sheet of acrylic glazing. The acrylic will protect the glass from breakage. The matting needed to cover the edges of the package will separate the surfaces of the glazing materials, ensuring that no Newton rings will be produced by contact between the surface of the glazing materials. The viewer will see only the reflection on the surface of the outer layer of glazing and their visual experience will not be marred by two sets of reflections.

Materials such as rubber or wood may be enclosed in a sealed package without ventilation to the exterior of the frame. Sealing a rubber item in a frame will at least limit its exposure to atmospheric oxygen and will shield metals, especially silver, from the sulfur that the rubber will emit. The acids and peroxides that wooden items emit will affect the wood itself, but should not lead to its physical breakdown if the wood is sealed.

The sealed package for these sorts of items should include a support made of conservation-quality board with margins large enough so that heat can be applied to the edges (in order to bond the sealing laminate to the glazing) without any heat reaching the item itself. The inclusion of scavenging materials in the support mat should benefit the enclosed item. These scavengers can include calcium carbonate or zeolite found in matboard, copper-impregnated polyethylene, silver cloth, or paper impregnated with active charcoal.

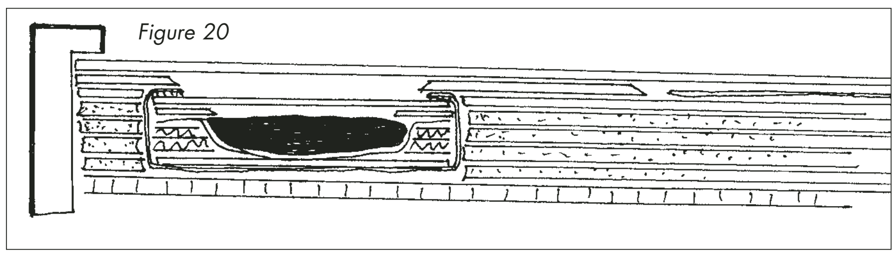


Figure 20

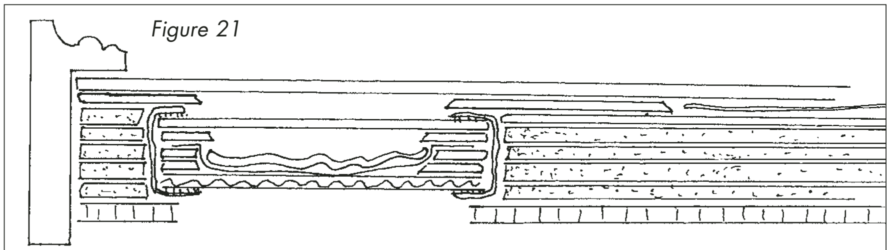
The glass that forms the front of the enclosure can be given a bead of electrical grade, hot melt adhesive so that the plastic/metal laminate film can be bonded to its front edge with heat. Since the package will be held shut with the bonded laminate, the item can be set in a sink formed to the item's contours and held away from the glazing by a window mat, without any further closure necessary. In cross-section, one such package could look like Figure 20.

Early plastics are a more difficult challenge. Cellulose modified by acetic, nitric, or other acids will produce those same acids over time. These materials have shown a pronounced tendency to self-destruct, and enclosure in a sealed package may aggravate their condition as the acids accumulate and cause further breakdown of the cellulose. These materials are difficult to maintain in the dark and their inclusion in a frame must be discouraged.

If they have to be included, they should be isolated from anything else in the frame and provisions should be made so that their gaseous by-products can safely escape from the frame. When such items are isolated in the frame, the package in which they are enclosed should be made so that any off gassing can only escape out the back of the frame.

Here, the package should be faced with glass, have sides of metal/plastic laminate, and a back of conservation-quality matboard and acid-free corrugated board. The backing board should be open to the air behind the frame. This may entail its being inset in the larger backing board which supports the entire contents of the frame. This package could look like Figure 21.

Figure 21



The vast majority of materials presented to framers for framing are chemically stable and the only risk they pose is their potential sensitivity to light. When sports and other memorabilia are proposed for inclusion in a shadow box, the possibility of substitution of a facsimile and storage of the original material in a box should be the first option.

Special Glazing Considerations

Most frames can be successfully fit with either glass or acrylic sheet; sealed frames have special considerations. Acrylic has the advantage of being virtually shatterproof in a frame and can be found in a wide variety of thickness and sizes, with or without an ultraviolet absorber. Glass has more modest cost, low static potential, and can act as a vapor barrier, which makes it valuable for the creation of sealed packages. Acrylic is hygroscopic and can transmit water vapor. It can warp if the two sides of the sheet are exposed to differing levels of relative humidity.

For anti-reflectivity and stability in sealed packages that are expected to resist climate change, glass is the only option, with its heat resistance and vapor barrier potential. The critical problem with glass is its fragility.

Lamination of two lites of glass with a flexible core material is the obvious answer. The fact that most thin, flat glass is strengthened with iron creates an aesthetic problem, since the presence of iron in the glass imparts a green tint, and when this tint is multiplied through lamination, the resulting color seriously affects its color rendering. Glass with low iron content is beginning to become available to framers, with and without anti-reflective coating. Low iron, anti-reflective, laminated glass has enjoyed widespread usage in museums, but its high cost and limited availability has kept it from use in general framing.

The combination of no reflections, utter clarity, ultraviolet control, effective vapor barrier potential, and shatter resistance adds up to the ultimate in glazing products—virtual invisibility with profound protection. However, its cost will likely keep it in the highest end of the framing market. If the anti-reflective coatings are left out, the resulting product would have all but one of those attributes and should be available at a much lower cost.

Such low iron, UV absorbing, laminated glass could be made without the production demands (and therefore high cost) of AR glass. This glass could be used in framing valuable works, ensuring their safety and the clear rendering of their colors. It could be use in the creation of highly sealed packages that would not lose their initial conditioning over time. The only impediments to introduction of such a product are the need for more two-millimeter, low iron glass and the skill needed for sizing laminated glass.

Trimming lites of laminated glass to specific sizes entails scores being made on the sheet at the appropriate point on both. The scores must be run, or cracked open, with a combination of tapping along them with a screwdriver and very gentle pressure. The tapping and pressure will open the score that is on the lite of glass that is on the bottom. When both scores have been run and this fact has been confirmed through careful examination with a raking light, the sheet can be gently flexed along the open scores to expose the plastic laminate for cutting. Once the excess has been removed, the edges of the glass can be dulled with an edge seamer.

When a laminated glass product is not available, the simplest approach would be to install a sheet of acrylic in front of a sealed package that has been made with glass. If the two glazing sheets are spaced apart with strips of matboard, they should not touch and Newton rings should be prevented. Also, the fact that there are two sets of reflections will not be evident enough to cause an aesthetic distraction.

This type of package will give some protection from breakage, but a strong blow to the surface of the outer layer of glazing or severe corner-to-corner twisting could break the inner layer of glass. This would leave the art exposed to broken glass edges.

Reversing the layers of glass and acrylic can address this problem. This strategy, which was suggested by Virginia Ritchie, a museum preservation framer, will entail the creation of a thicker package, which must be strengthened to accommodate the acrylic sheet within, but it will eliminate any possibility of glass shards cutting the art.

This package can be made using the same aluminum/plastic laminate sheet and electrical-grade hot melt adhesive as the packages described earlier.

The hot melt that is used to seal the

package can also be used to hold the acrylic sheet and the glass apart. While the bead of hot melt is being extruded onto the edges of the lite of glass, a similar bead can be set on the edges of the acrylic. This latter layer of glue should be thick enough to hold the glazing layers far enough apart to avoid Newton rings.

The fact that there will be an extra layer of glazing, and the spacing needed to accommodate it, means that the package will be thicker than normal. In a normal package for a matted work, the laminate sheet should be at least 1" larger than the glazing on each side. Here the laminate should be an 1 1/2" larger than the glazing on all sides.

The other difference between this package and an ordinary one is the inclusion of the sheet of acrylic inside the package. If the walls of the package were not reinforced, the acrylic sheet inside the package might shift during handling and rupture the laminate that surrounds it. The laminate comprises four layers, (nylon on the outside, polyethylene, aluminum, and polyethylene), and if its integrity is challenged on the inner polyethylene side, it will begin to give way before the tougher nylon layer is reached.

The best way to prevent any threat to the sides of the package from the glazing involves reinforcing the sides with another layer of laminate. Strips of laminate roughly 1" wide, and as long as the vertical and horizontal dimensions of the glazing, should be prepared. The cleaned glazing combination can be fitted to the front of the mat package.

The laminate sheet can now be laid on the work surface with its polyethylene side up and the mat/glazing package can be laid in the center of the sheet. A 1" strip of appropriate length can be slipped between the back of the mat and the front of the sheet of laminate. The strip should be placed so that its polyethylene side is down and its nylon side is up. It should be adjusted so that it extends out from under the mat just far enough that it will cover the side of the package when it is pulled around to the front of the glazing, but it will not extend around to the front of the glazing.

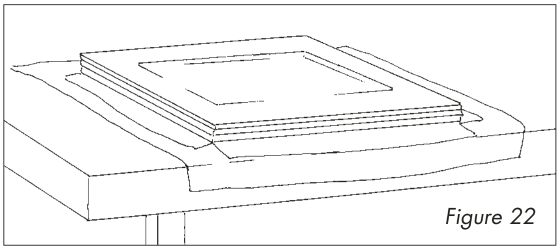


Figure 22

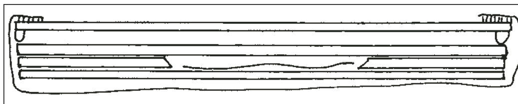


Figure 23

When this position has been achieved, the package can be carefully moved to the edge of the work surface and stationed at the proper distance so that the portion of the sheet not covered by the 1" strip can be folded down over the edge of the table. This will keep it from becoming stuck to the tacking iron when heat is used to attach the strip to the laminate sheet [Figure 22].

The tacking iron is now used to bond the strips in place. When that has been completed, the laminate is pulled onto the hot melt glue on the front edges of the glass and bonded with heat, as usual. The finished package will look like the cross-section seen in Figure 23.

The added thickness of this type of package will make the closure of the front corners a bit more difficult. The laminate will seal best if it is pulled onto the front of the glazing in a number of small folds, and the thicker side of this package will tend to reinforce the tendency of the laminate to fold only along the corner edge. A bit of practice at manipulating the laminate into multiple folds will lead to the production of fully successful corners and well-sealed packages.

The two layers of glazing will reduce the transmission of light and low iron or water white glass is very helpful here. It can be combined with UV-filtering acrylic to create a package that is both safe and attractive.

Using two layers of glazing will add to the cost of the frame and will require the use of a frame with a deeper rabbet. However, the labor required for the creation of a highly sealed package already increases its price and the preservation benefits that this technology confers on high value items should be worth the extra cost.

A similarly sealed package can be made for enclosing paintings and objects as well. However, its design will differ from the matted package since it cannot be sealed with heat around the front margins of the glazing due to the proximity to the work inside the package.

A package that has two layers of glazing will look best if the glazing materials are as clear as possible. Fortunately, low iron or water white glass with anti-reflective coatings can be had from more than one vendor and will enhance the appearance of the work within. However, the AR glass will not cancel the reflections on the acrylic and some of its efficacy may be lost when it is combined with the acrylic. If an ultraviolet absorber is needed, it can be provided through the inclusion of an absorber in the acrylic or in a coating on the glass.

Creating the package begins with the glass being thoroughly cleaned and beads of electrical grade hot melt adhesive being extruded onto the outer edges of both sides of the glass.

Strips of plastic/aluminum laminate can be used. Whichever material is chosen, it can then be cut so that they are 3" to 4" wide and longer than each side of the glass by twice the width of the strips.

The polyethylene side of these strips can be bonded to the hot melt with a tacking iron so that the strips overlap onto the front of the glass by 1/8" and will overlap the neighboring strips at each end. When the hot melt is flattened and the surface of the laminate is finely wrinkled, the bond should be complete.

The overlapping ends of the strips can now be folded up above the front of the glass so that their polyethylene sides meet along a mitered line extending out from the corner of the glass for heat bonding there.

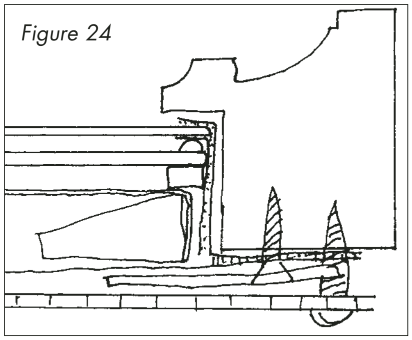
When the corners have been bonded, the glass can be turned over and four more strips of laminate, 2" wide and equal in length to the sides of the glass, can be heat bonded to the inside of the outer strips. The inner strips should be positioned so that they lap onto the bead of hot melt on the inner surface of the glass and they should be bonded onto the outer strips to a width, equal to the width of the tacking iron.

When this is complete for all four sides, the package can be stood on edge and heat applied to the outside of the outer strips at each corner. This will form a joint that is perpendicular to the plane of the glass. The package is now ready for installation in the frame.

The bulk of the laminate that surrounds the edges of the glass will probably require that the frame be rabbeted out to accommodate it. The glass should not be cut smaller than normal to fit the frame, since that would make the package too tight for its painting.

If, instead, the rabbet dimensions of frame are enlarged, the frame will have a larger lip or rabbet width and should cover the laminate at the edge of the glass, while giving adequate room for the painting [Figure 24]. The acrylic that will fit inside the package should be sized so that it is 1/16" smaller than the glass. That will allow it to fit inside the package.

Figure 24



Its edges should be rounded with an edge seamer or a plastic file so that they will not puncture the walls of the package. A bead of hot melt can be extruded onto the edges of one side of the acrylic to form a spacer that will keep its surface from touching the surface of the glass.

The cleaned acrylic can be fitted inside the cleaned glass of the package, without bonding to the glass or package. This will allow for the two layers to be separated when a piece of framing detritus is spied in between them. A spacer of conservation-quality board or painted balsa can be tacked onto the surface of the acrylic with hot melt to keep the painting away from its surface, before the acrylic is installed in the package.

Finally, the painting is fitted into the package as it sits in the frame, and a sheet of laminate is heat bonded to the outer edges of the package, where they overlap the back side of the frame. The painting is secured with pressure applied through the back sheet of laminate by brass mending plates. These plates are screwed to the back of the frame through the bonded part of the package and a sheet of polypropylene double-wall is screwed to the frame through that same bonded outer portion of the package to protect the package and the painting from punctures.

This sort of enclosure, if properly conditioned and sealed, will protect its contents for as long as the seal is maintained. The longevity of such protection is even more important in a private setting than it is a museum, where works are routinely unframed as part of their maintenance.

Our increasing experience with such enclosures will inform our future designs, increasing their durability and powers of sequestration, but preservation must always be seen as a continuing enterprise, where items not left in even the most carefully designed enclosures forever, but are monitored regularly and carefully to ensure their safe maintenance. ■

Hugh Phibbs has worked in preservation framing for more than 25 years; in a commercial shop and in the Conservation Division of the National Gallery of Art. He was a compiler of the Matting/Framing section of the Book and Paper Group of the American Institute for Conservation's Treatment Outline. He is a Professional Associate of the American Institute for Conservation and a former board member of the Washington Conservation Guild. He has written "Preservation Practices," a monthly column on preservation and numerous preservation supplements for Picture Framing Magazine, as well as an article on preservation for Decor magazine. He has taught workshops for the conservation programs at Winterthur, NYU, and SUNY, Buffalo. He has also taught classes for the American Institution for Conservation, The Smithsonian Resident Associate's Program, the PPFA, PFM Seminars and The National Conference.

Chemical Interactions Inside the Frame

Once frame sealing is considered, a brief overview of chemical issues in framing can be useful.

The choices for glazing between glass and polymer sheeting does not have too many chemical consequences. Both types of material have long histories of intimate proximity to sensitive objects with little appreciable effect.

When works are in contact with glass, there may be some possibility of chemical change on the part of the glass. The white material which can be seen as a ghost image on the glass of some old frames has proven in some cases to be sodium chloride (table salt). This may result from sodium, which is a very common component of glass, leaching out of the glass and combining with chlorine contributed by something in the environment.

This is a situation which can be avoided by properly spacing the work in the frame away from the glass. Even if salt were transferred to the surface of the paper, it may not have consequences which are too devestating. Salt has been used in some watercolor and photographic techniques without obvious degradation of the paper.

When ultraviolet absorbers are included in glazing materials, they should not pose a chemical danger. In the case of glasses, they will be deposited on the surface in a matrix which will contain them, or they will be in the laminate between two lites of glass. In the case of acrylic sheet, they will be in the body of the sheet and should not be expected to migrate out. The presence of the ultraviolet light absorber will have the effect of reducing the chemical reactions in the art as it removes the most energetic wavelengths and the chemical changes which they would initiate.

The role that a frame might play in the chemical interactions within a frame package will depend on its material and design. A metal frame is not likely to be made of an alloy or metal which would oxidize readily. (This is because the oxidation would be aesthetically disfiguring.) Metal coverings used on frames are also likely to be either non-tarnishing (like gold) or sealed.

Thus, framers are likely to encounter anodized aluminum, karat gold, or brass, aluminum, or silver leaf which has been coated. Each of these materials should have little chemical potential for interacting with the contents of the frame. Indeed, metal coverings on wooden frames can reduce the potential which the wood has to affect the framed material chemically.

Since all wood has lignin binding it together, it has the potential to cause discoloring oxidation in materials to which it is proximate. If the art is separated by a barrier layer lining the rabbet or by a wide enough expanse of mat board, (1"), it should be safe from this degradation.

The recent advent of frames made of synthetic polymers raises the issue of their potential off gassing. The brevity of our experience with these materials means that we lack anecdotal evidence for their behavior over time. It may be that some of them will not contribute chemically to the materials which they enclose, but until that has been shown, it is wise to treat they as if they were as reactive as wood and provide for a barrier between them and the art or a distinct buffering margin of mat board.

Matting materials can provide the most chemically beneficial component of the entire frame. They can support the art and insulate it from physical damage without causing chemical change.

The cellulose which is the primary constituent of mat board is chemically stable, especially in its non-branching, or alpha, type. A layer of pure cellulose is the best choice for a material which will come in contact with a work of art on paper. If pigment is added throughout the board, it is unlikely to pose a chemical problem. The pigment should be kept below the level of density at which it might rub or crock off onto the art to avoid physical problems.

Since the fibers which comprise the board will not receive printing, the need for harmful sizings, such as are found in some papers, is not present. Any finishing or sizing of the board is likely to be benign, since manufacturers frequently use such exacting standards as the Photo Activity Test for assaying their products. When calcium carbonate or molecular sieves are added to the board, they provide more protection for the board itself and the material it houses.

The material which comprises the backing board is usually selected for its ability to provide rigidity and resistance to punctures without significant weight or expense. The best papers used in these boards are free of lignin and harmful additives. This will extend their useful life and eliminate any possible chemical contribution to the frame package from that source. When backing boards contain plastics, they are likely to be polypropylene or polystyrene. These can be weakened by oxidation and ultraviolet. Since they will not be exposed to light, the latter problem is not likely to result and, therefore, off gassing from that source is unlikely. Indeed, any off gassing which occurs is likely to be minimal.

Since the backing board should be isolated from the art by at least one sheet of conservation-quality board, its potential for reacting with the art is limited. The role it plays in sequestering the art from chemical change from without is more relevant. Here, the polymers in the boards can slow the passage of atmospheric gasses into the package. ■