

MATERIALS INFORMATION and TECHNICAL RESOURCES for ARTISTS - Rigid Supports

There are pros and cons to all solid and flexible supports. Generally speaking, an ideal support will be able to withstand fluctuations in RH and temperature, possess an adequate level of absorbency and/or tooth, remain planar and resist warping, and not become brittle or fragile with age.

One drawback often associated with flexible supports is that they are more susceptible to being damaged by physical impact (e.g. tears, impact cracks, punctures, etc.) Flexible supports made from cellulose like cotton and linen are more likely to respond to changes in the environment, giving rise to draws in the corners, an overall loss of tension, and other planar deformations. Such damages can lead to both short and long term condition issues and can affect the stability of the paint and ground layers. Because of these issues, artists are highly encouraged to affix protective backing boards to the reverse of their paintings. This helps to prevent physical impacts from the reverse and help to buffer and slow the fabric's response to changes in humidity.

Rigid supports made from hygroscopic materials like wood are less likely to withstand physical damage but will still react to changes in the environment (e.g. warping, cracking, etc.) which can adversely affect the ground and paint layers. There are steps that artists can take to mitigate some of these problems. One method is to adhere a fabric support over the face of the rigid panel. The fabric can serve as a less brittle interlayer which may stop the crack or split from telegraphing from the support to the ground and paint layers should the rigid support exhibit warping and/or cracking. Rigid supports can also be cradled or braced, particularly if they are large in size, to counteract possible warping or other types of planar deformations.

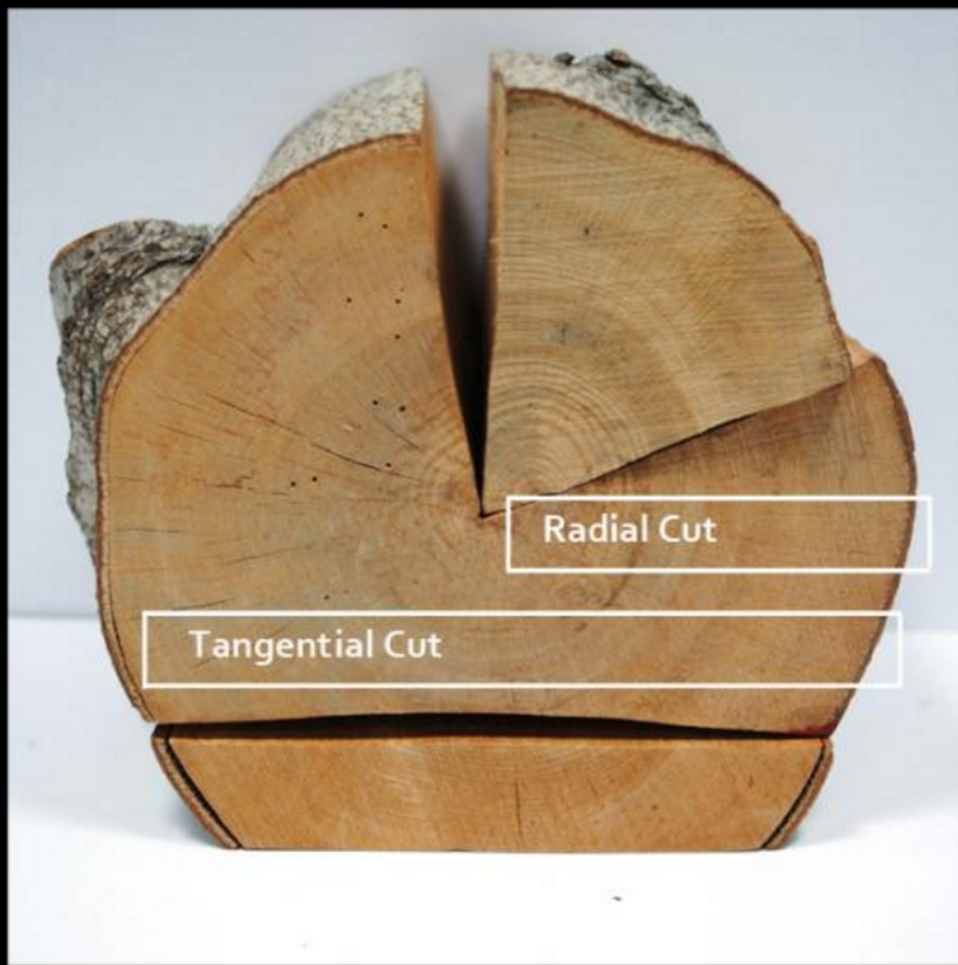
RIGID SUPPORTS

Many different solid support materials are available to artists. These materials include wood, metal, and modern composite materials. As there are pros and cons associated with any choice of solid support, artists should keep in mind the size, ground, and paint layers that will be applied when selecting and preparing their substrates. The following is information about a number of types of solid supports that are currently available to artists. Additional information on historical and contemporary practices relating to rigid supports is available in the section containing online resources and references.

Solid Wood Panels

For centuries painters have used hardwoods (from deciduous trees and narrow-leaved evergreens) and semi-hardwoods (partially matured cuttings from deciduous trees) including oak, mahogany, chestnut, and poplar have been used as

supports. The long-term ageing properties of solid wood panels depend on the type and cut of wood. Sapwood is the outermost portion of a tree trunk (the living part of the tree), while heartwood is the trunk's inner (dead) core. Heartwood is more suitable for use for painting supports as it shrinks and swells less than sapwood. All solid wood panels are susceptible to some degree of warping, shrinkage or expansion. This can be lessened by the selection of the more appropriate cuts of wood (*radial* rather than *tangential*), proper preparation (ageing and drying) of the wooden support, and the method of treatment (finishing both sides of the panel in a similar manner). Some types of wood are more likely to experience attacks by wood-boring insects. This should be taken into consideration when selecting and preparing a wooden support.



Two common cuts of wood are *radial* and *tangential*. Radial cuts radiate out from the center of the log and are most stable over time if the centermost portion of the log (the pith) is removed. Tangential cuts are less stable and more susceptible to warping.

The stability of a wooden board is greatly influenced by where it was cut from the original tree trunk. Wood expands and contracts in the direction perpendicular to the grain direction. Wooden boards tend to be most stable when they are most similar on the front and back. Tangentially sawn planks are prone to planar deformations like warping, splitting, and cracking as these planks often contain both sapwood and heartwood and the number of grain lines are very different on the front as compared to the back. Radially sawn planks are generally more stable. When a panel support is comprised of multiple planks, the orientation of the wood grain has an effect on the stability of the panel. If the grain of adjoining planks is oriented perpendicular to one another, structural problems can arise when the support experiences environmental fluctuations. Therefore, if multiple planks are to be joined together, all of the planks should have the wood grain oriented in the same direction. Supports created from multiple planks can develop splits and cracks along the joins when subjected to adverse environmental conditions, and tension between the sections of the wood can result in cracking or splitting. Artists who work on a larger scale should keep this in mind when selecting and/or preparing wooden panel supports.

When artists use wooden supports, they should:

- Considering using well-seasoned hardwoods like mahogany, maple, or oak. Inspect the surface of the panel to ensure that no knots, cracks, or other deformations are present.
- Use planks that are at least 2.5 cm (1") thick, as thinner boards are more likely to suffer structural deformation.
- Avoid semi-hardwoods and soft woods like poplar and pine when possible. If these woods are chosen, it is recommended that they be covered with a layer of canvas to prevent the transfer of splits and cracks from the support to the ground and paint layers. Larger format wooden supports comprised of multiple planks should also be covered with canvas (overall if possible or at least use canvas strips to cover joins/splits) to help prevent the transfer of splits and cracks from the support to the ground and paint layers.
- Consider sizing (and possibly priming) both sides of the support in order to mitigate potential warping in the future. This procedure ensures that both sides of the panel will respond more similarly to environmental changes. Possible sizing materials to consider include neutral pH PVA, certain acrylic polymers (e.g. high quality acrylic dispersion mediums or gels), and varnish coatings (e.g. Regalrez 1094, MSA varnishes, etc.). Refined shellac and polyurethane coatings have also been used to effectively reduce the absorbency of the surface and to seal the wood but artists should take care not to apply these materials too thickly. Shellac and polyurethane are less than ideal materials in terms of reversibility, brittleness and aging characteristics.
- Consider applying an even coat of neutral pH PVA adhesive or certain acrylic polymers (e.g. high quality acrylic dispersion mediums or gels)

when adhering canvas/paper to the surface of a panel following degreasing/cleaning of the surface. To adhere your canvas to a panel, the following steps are recommended:

Apply one even coat of PVA size or acrylic gel medium to the surface of the panel using a spatula or a brush. Lightly wet the reverse of the canvas (the side that will be adhered to the panel) with water to promote better adhesion. Use a brayer/bone folder to eliminate any air bubbles, working from the center outwards to the edges. If you have decided to keep excess fabric along the outer edges, fold them over and attach to the backside of the panel (or affix them later). Immediately apply another coat of PVA size or acrylic gel medium (stick to the same material you used previously) to the face of the canvas. Once the canvas has dried, apply a coat of PVA size or acrylic gel medium to the reverse of the panel to prevent potential warping.

- Consider using BEVA 371 adhesive/film to adhere canvas to panel after the panel has been sealed. BEVA film (as opposed to the adhesive) will not penetrate the fabric support as readily as PVA adhesive and/or acrylic mediums might and the ability to re-activate the adhesive makes it far easier to eliminate any unwanted air-bubbles later on should they form during the process. To adhere your canvas to a panel, the following steps are recommended:

Apply one to two even coats of dilute BEVA adhesive (thin cream consistency) to the panel after cleaning the surface and two coats to the reverse of the canvas (wear adequate protection as solvents are required). If you are using BEVA film it is better to use two sheets of film as opposed to one, although one sheet may be able to provide enough adhesion. Place the film with the BEVA-side facing the panel (or canvas if you are using two sheets) without removing the silicone-coated Mylar and apply heat evenly using an iron (BEVA adhesive requires a temperature of around 65.6 degrees Celsius to be re-activated). Weight down the surface until the BEVA has cooled and then carefully peel away the silicone-coated Mylar (NOTE: If you attempt to remove the Mylar too soon you will pull up the BEVA). If you are using two sheets, repeat this process with the other sheet of BEVA film when applying to the reverse of the canvas support (consider placing silicone-release paper/Mylar beneath the canvas when applying heat, silicone side facing up). Then position your canvas directly atop the BEVA film, place silicone-release paper/Mylar (silicone side facing down) atop the canvas, and apply heat. If you are using BEVA adhesive simply wait for the coats of BEVA to dry (in a well ventilated space) and repeat the aforementioned step. If you experience difficulties using BEVA film

try applying a coat of adhesive to the back of the canvas or switch to the adhesive altogether.

Consider using a temperature controlled vacuum table if you wish to adhere a completed painting onto a panel (in general this is not recommended). It *may* be possible to safely adhere your composition if it does not contain thickly built up paint, wax-based additives, or areas of strong impasto. Follow the instructions above but consider using a soft blotter paper over your silicone release paper/ Mylar to protect more delicate surfaces (you may also need to raise the temperature of your iron ever so slightly).

- Although rabbit skin/animal glue possesses hygroscopic properties, many artists continue to use this traditional material as a size and/or adhesive. To adhere your canvas to a panel using animal glue, the following steps are recommended:

Prepare your animal glue following the directions on the package. Brush a generous, even coat of glue onto the panel's surface. You may allow this coat to dry before continuing with the process or proceed immediately. Wearing nitrile gloves, immerse the canvas into the tepid glue (make sure that it is not so hot as to burn your hands), gently wring the fabric to remove excess glue. Position the fabric onto the panel. Use a brayer/bone folder to eliminate any air bubbles, working from the center outwards to the edges. If you have decided to keep excess fabric along the outer edges, fold them over and attach to the backside of the panel (or affix them later). Immediately apply a coat of glue to the reverse of the panel (NOTE: It is not advised to leave a coat of animal glue exposed to the environment. Subsequent layers of priming and paint need to be applied to the reverse in order to avoid warping, mimicking the same layering used on the front of the panel). Allow for adequate and even drying by standing the panel on its edge or leaning against a wall.

- Provide additional auxiliary support to large format panels and panels that are less than $\frac{3}{4}$ " thick by attaching a brace or cradle by gluing strips of wood around the outside edge of the back of the panel using the following steps:

Obtain 1" by 2" wooden boards (oak or maple are preferred) and cut them down to match the outer dimensions of the support (overall size will depend on what type of join is used for the corners). Butt and mitered tend to be the most common type of joins (consider using a 90 degree-corner clamp when making mitered corners), however lap joins are generally considered to be more structurally sound. Make sure that the wooden boards are

perfectly aligned and flush with the outer edges by laying them on the reverse of the panel before gluing to the reverse (it can help to mark the position with a pencil). Use carpenter's glue to adhere the wooden boards in place. While the glue is drying, clamp/weight the boards to avoid creating any air bubbles. For large-scale supports artists may choose to construct horizontal and/or vertical crossbars although crossbars should NOT be glued directly to the reverse of the panel, only fixed to the outer boards of the cradle using glue and/or hardware.

Plywood

Plywood is a laminated wood product that is prepared by adhering together layers of thin wood veneer (plies) with the grain of each layer positioned at right angles to the grain of the preceding layer. Some types of plywood are available with a lumber, or solid wood, core.

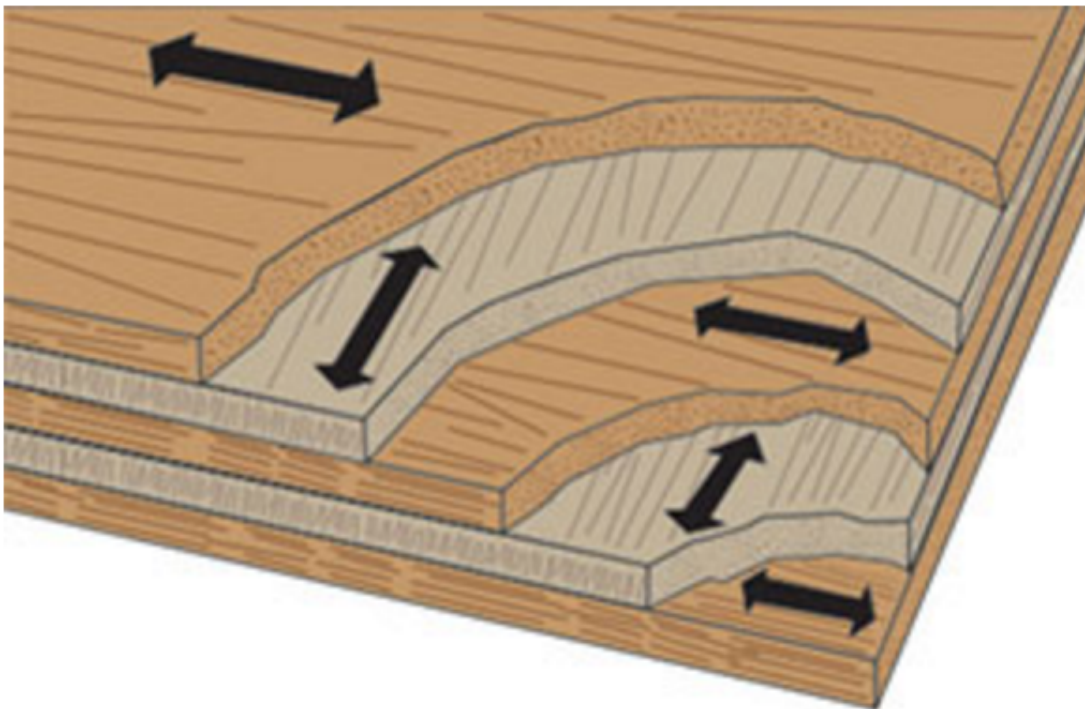


Diagram showing the alternating directional grain of a 5-ply, wooden support. Some types of plywood are also available with a solid wood core.

The cross-laminate structure of plywood -- particularly if the plies are all of equal thickness--helps ensure that the support is less prone to planar deformation. Plywood can be made from a variety of soft and hard woods. The latter tends to be more dimensionally stable. In general, the more layers, the more dimensionally

stable the plywood support. Exterior-grade plywood has superior resistance to moisture, while interior-grade plywood has the smoothest surface finish.

Gatorfoam board or Gatorboard is not plywood. It is composed of extruded polystyrene foam bonded between two layers of wood-fiber veneer. It provides a very rigid surface, but the wood-fiber layers may respond to changes in the environment.

Plywood and especially Gatorboard panels are not considered sufficiently stable for permanent use. Artists may be able to mitigate some of the problems associated with these substrates by considering the following recommendations:

- Inspect the surface of plywood to ensure that there are no knots, cracks, or other deformations.
- Choose maple, walnut, or mahogany plywood which are more durable and stable (birch plywood can also be used, but the grain has a tendency to transfer through to the ground and paint layers over time).
- For larger works choose plywood that is at least ¾" thick as this exhibits adequate dimensional stability.
- Plywood and Gatorboard panels may benefit from adhering a fabric layer to the surface before priming. These panels should be stored flat.
- Consider sizing (and possibly priming) both sides of the support in order to mitigate potential warping in the future. Possible sizing materials to consider include neutral pH PVA, certain acrylic polymers (e.g. high quality acrylic dispersion mediums or gels), and varnish coatings (e.g. Regalrez 1094, MSA varnishes, etc.). Refined shellac and polyurethane coatings have also been used to effectively reduce the absorbency of the surface and to seal the wood but artists should take care not to apply these materials too thickly. Shellac and polyurethane are less than ideal materials in terms of reversibility, brittleness and aging characteristics.
- Consider applying an even coat of neutral pH PVA adhesive or certain acrylic polymers (e.g. high quality acrylic dispersion mediums or gels) when adhering canvas/paper to the surface of a panel following degreasing/cleaning of the surface. To adhere your canvas to a panel, the following steps are recommended:

Apply one even coat of PVA size or acrylic gel medium to the surface of the panel using a spatula or a brush. Lightly wet the reverse of the canvas (the side that will be adhered to the panel) with water to promote better adhesion. Use a brayer/bone folder to eliminate any air bubbles, working from the center outwards to the edges. If you have decided to keep excess fabric along the outer edges, fold them over and attach to the backside of the panel (or affix them later). Immediately apply another coat of PVA size or acrylic gel medium (stick to the same material you used previously) to the face of the canvas. Once the canvas has dried,

apply a coat of PVA size or acrylic gel medium to the reverse of the panel to prevent potential warping.

- Consider using BEVA 371 adhesive/film to adhere canvas to panel after the panel has been sealed. BEVA film (as opposed to the adhesive) will not penetrate the fabric support as readily as PVA adhesive or acrylic mediums might and the ability to re-activate the adhesive with heat makes it far easier to later address any unwanted air-bubbles should they form during the procedure. To adhere your canvas to a panel, the following steps are recommended:

Apply one to two even coats of dilute BEVA adhesive (thin cream consistency) to the panel after cleaning the surface and two coats to the reverse of the canvas (wear adequate protection as solvents are required). If you are using BEVA film it is better to use two sheets of film as opposed to one, although one sheet may be able to provide enough adhesion. Place the film with the BEVA-side facing the panel (or canvas if you are using two sheets) without removing the silicone-coated Mylar and apply heat evenly using an iron (BEVA adhesive requires a temperature of around 65.6 degrees Celsius to be re-activated). Weight down the surface until the BEVA has cooled and then carefully peel away the silicone-coated Mylar (NOTE: If you attempt to remove the Mylar too soon you will pull up the BEVA). If you are using two sheets, repeat this process with the other sheet of BEVA film when applying to the reverse of the canvas support (consider placing silicone-release paper/Mylar beneath the canvas when applying heat, silicone side facing up). Then position your canvas directly atop the BEVA film, place silicone-release paper/Mylar (silicone side facing down) atop the canvas, and apply heat. If you are using BEVA adhesive simply wait for the coats of BEVA to dry (in a well ventilated space) and repeat the aforementioned step. If you experience difficulties using BEVA film, try applying a coat of adhesive to the back of the canvas or switch to the adhesive altogether.

Consider using a temperature controlled vacuum table if you wish to adhere a completed painting onto a panel (in general this is not recommended). It *may* be possible to safely adhere your composition if it does not contain thickly built up paint, wax-based additives, or areas of strong impasto. Follow the instructions above but consider using a soft blotter paper over your silicone release paper/ Mylar to protect more delicate surfaces (you may also need to raise the temperature of your iron ever so slightly).

- Although rabbit skin/animal glue possesses hygroscopic properties, many artists continue to use this traditional material as a size and/or

adhesive. To adhere your canvas to a panel using animal glue, the following steps are recommended:

Prepare your animal glue following the directions on the package. Brush a generous, even coat of glue onto the panel's surface. You may allow this coat to dry before continuing with the process or proceed immediately. Wearing nitrile gloves, immerse the canvas into the tepid glue (make sure that it is not so hot as to burn your hands), gently wring the fabric to remove excess glue. Position the fabric onto the panel. Use a brayer/bone folder to eliminate any air bubbles, working from the center outwards to the edges. If you have decided to keep excess fabric along the outer edges, fold them over and attach to the backside of the panel (or affix them later). Immediately apply a coat of glue to the reverse of the panel (NOTE: It is not advised to leave a coat of animal glue exposed to the environment. Subsequent layers of priming and paint need to be applied to the reverse in order to avoid warping, mimicking the same layering used on the front of the panel). Allow for adequate and even drying by standing the panel on its edge or leaning against a wall.

- Provide additional auxiliary support to large format panels and panels that are less than $\frac{3}{4}$ " thick by attaching a brace or cradle by gluing strips of wood around the outside edge of the back of the panel using the following steps:

Obtain 1" by 2" wooden boards (oak or maple are preferred) and cut them down to match the outer dimensions of the support (overall size will depend on what type of join is used for the corners). Butt and mitered tend to be the most common type of joins (consider using a 90 degree-corner clamp when making mitered corners), however lap joints are generally considered to be more structurally sound. Make sure that the wooden boards are perfectly aligned and flush with the outer edges by laying them on the reverse of the panel before gluing to the reverse (it can be helpful to mark the position with a pencil). Use carpenter's glue to adhere the wooden boards in place. While the glue is drying, clamp/weight the boards to avoid creating any air bubbles. For large-scale supports artists may choose to construct horizontal and/or vertical crossbars although crossbars should NOT be glued directly to the reverse of the panel, only fixed to the outer boards of the cradle using glue and/or hardware.

Hardboards, Fiberboards, etc.

The terms “hardboard” and “fiberboard” are often used interchangeably despite the fact that they are different products. The major difference between hardboards such as fiberboard panels like Medium Density Fiberboard and High Density Fiberboard (e.g. Masonite) is the way in which they are manufactured.

Hardboard panels are generally created through a wet/dry process which relies on naturally present cellulosic lignin in the wood to cement the fibers together. Tempered hardboards are impregnated with an oily or resinous substance making them darker in color (untempered hardboards are usually a light brown color) and more resistant to moisture and mechanical damage (and therefore subsequent warping, raising of fibers, etc.) than untempered hardboard. Support-induced discoloration (SID) will occur if the oily or resinous material migrates through the size or sealant and stains the ground and/or paint layers. Masonite, one of the most commonly manufactured hardboards, first began to be used for artistic purposes in the late 1920s

Fiberboard panels are created through a dry process that relies on chemical agents like urea-formaldehyde to bind the wood fibers together. High Density Fiberboard (HDF) is superior to Medium Density Fiberboard (MDF) as it has significantly higher internal bond strength and is less susceptible to moisture damage. However, HDF is still prone to planar deformation. Proper sealing or sizing and ground application can mitigate this problem.

Clayboards are high-density fiberboards that have been coated with a layer rich in clay (kaolin). Because the clay layer serves as a stable ground, clayboards are not prone to support-induced discoloration (SID). Ampersand Art Supply is a major distributor of clayboards (and other solid supports for artists).

The advantages of these boards over wood are that they are available in large sheets, have no grain (i.e., no directional movement), and are not as sensitive to climatic changes or attack by wood-boring insects. Large sheets do tend to warp and twist and corners can become bent, compressed, or expanded. Untempered hardboards should not be used if long-term preservation is a concern. Untempered hardboard was once preferred over tempered due to the earlier use of substantial amounts of oil incorporated into the earlier tempering formulations which could make them inappropriate as a surface to receive water containing grounds. High quality hardboards purchased from respected suppliers do not suffer from this defect.

When artists choose to use these supports, they should:

- Degrease the surface with denatured alcohol before applying layers of size, ground, and/or paint. Without this preparation, ground layers may not adhere to the smooth side of these supports because of surface

residues such as paraffin wax that may be left during the manufacturing process.

- Gently sand the face of the panel with fine sandpaper (e.g. 220 grit) to provide a slight mechanical tooth but be careful to not overly roughen the surface and unevenly expose the wood fibers. This can lead to irregular swelling of the substrate (particularly when water-based sizes, sealants and/or priming/ground are applied).
- Consider sizing (and possibly priming) both sides of the support in order to mitigate potential warping in the future. Possible sizing materials to consider include neutral pH PVA, certain acrylic polymers (e.g. high quality acrylic dispersion mediums or gels), and varnish coatings (e.g. Regalrez 1094, MSA varnish, etc.). Refined shellac and polyurethane coatings have also been used to effectively reduce the absorbency of the surface and to seal the wood but artists should take care not to apply these materials too thickly. Shellac and polyurethane are less than ideal materials in terms of reversibility, brittleness and aging characteristics.
- Consider applying an even coat of neutral pH PVA adhesive or certain acrylic polymers (e.g. high quality acrylic dispersion mediums or gels) when adhering canvas/paper to the surface of a panel following degreasing/cleaning of the surface. To adhere your canvas to a panel, the following steps are recommended:

Apply one even coat of PVA size or acrylic gel medium to the surface of the panel using a spatula or a brush. Lightly wet the reverse of the canvas (the side that will be adhered to the panel) with water to promote better adhesion. Use a brayer/bone folder to eliminate any air bubbles, working from the center outwards to the edges. If you have decided to keep excess fabric along the outer edges, fold them over and attach to the backside of the panel (or affix them later). Immediately apply another coat of PVA size or acrylic gel medium (stick to the same material you used previously) to the face of the canvas. Once the canvas has dried, apply a coat of PVA size or acrylic gel medium to the reverse of the panel to prevent potential warping.

- Consider using BEVA 371 adhesive/film to adhere canvas to panel after the panel has been sealed. BEVA film (as opposed to the adhesive) will not penetrate the fabric support as readily as PVA adhesive or acrylic mediums might and the ability to re-activate the adhesive with heat makes it far easier to later address any unwanted air-bubbles should they form during the procedure. To adhere your canvas to a panel, the following steps are recommended:

Apply one to two even coats of dilute BEVA adhesive (thin cream consistency) to the panel after cleaning the surface and two coats to the reverse of the canvas (wear adequate protection as solvents

are required). If you are using BEVA film it is better to use two sheets of film as opposed to one, although one sheet may be able to provide enough adhesion. Place the film with the BEVA-side facing the panel (or canvas if you are using two sheets) without removing the silicone-coated Mylar and apply heat evenly using an iron (BEVA adhesive requires a temperature of around 65.6 degrees Celsius to be re-activated). Weight down the surface until the BEVA has cooled and then carefully peel away the silicone-coated Mylar (NOTE: If you attempt to remove the Mylar too soon you will pull up the BEVA). If you are using two sheets, repeat this process with the other sheet of BEVA film when applying to the reverse of the canvas support (consider placing silicone-release paper/Mylar beneath the canvas when applying heat, silicone side facing up). Then position your canvas directly atop the BEVA film, place silicone-release paper/Mylar (silicone side facing down) atop the canvas, and apply heat. If you are using BEVA adhesive simply wait for the coats of BEVA to dry (in a well ventilated space) and repeat the aforementioned step. If you experience difficulties using BEVA film, try applying a coat of adhesive to the back of the canvas or switch to the adhesive altogether. Consider using a temperature controlled vacuum table if you wish to adhere a completed painting onto a panel (in general this is not recommended). It *may* be possible to safely adhere your composition if it does not contain thickly built up paint, wax-based additives, or areas of strong impasto. Follow the instructions above but consider using a soft blotter paper over your silicone release paper/ Mylar to protect more delicate surfaces (you may also need to raise the temperature of your iron ever so slightly).

- Although rabbit skin/animal glue possesses hygroscopic properties, many artists continue to use this traditional material as a size and/or adhesive. To adhere your canvas to a panel using animal glue, the following steps are recommended:

Prepare your animal glue following the directions on the package. Brush a generous, even coat of glue onto the panel's surface. You may allow this coat to dry before continuing with the process or proceed immediately. Wearing nitrile gloves, immerse the canvas into the tepid glue (make sure that it is not so hot as to burn your hands), gently wring the fabric to remove excess glue. Position the fabric onto the panel. Use a brayer/bone folder to eliminate any air bubbles, working from the center outwards to the edges. If you have decided to keep excess fabric along the outer edges, fold them over and attach to the backside of the panel (or affix them later). Immediately apply a coat of glue to the reverse of the panel (NOTE: It is not advised to leave a coat of animal glue exposed to

the environment. Subsequent layers of priming and paint need to be applied to the reverse in order to avoid warping, mimicking the same layering used on the front of the panel). Allow for adequate and even drying by standing the panel on its edge or leaning against a wall.

- Provide additional auxiliary support to large format panels and panels that are less than $\frac{3}{4}$ " thick by attaching a brace or cradle by gluing strips of wood around the outside edge of the back of the panel using the following steps:

Obtain 1" by 2" wooden boards (oak or maple are preferred) and cut them down to match the outer dimensions of the support (overall size will depend on what type of join is used for the corners). Butt and mitered tend to be the most common type of joins (consider using a 90 degree-corner clamp when making mitered corners), however lap joins are generally considered to be more structurally sound. Make sure that the wooden boards are perfectly aligned and flush with the outer edges by laying them on the reverse of the panel before gluing to the reverse (it can helpful to mark the position with a pencil). Use carpenter's glue to adhere the wooden boards in place While the glue is drying, clamp/weight the boards to avoid creating any air bubbles. For large-scale supports artists may choose to construct horizontal and/or vertical crossbars although crossbars should NOT be glued directly to the reverse of the panel, only fixed to the outer boards of the cradle using glue and/or hardware.

Laminated Paper Boards and Museum Boards

Paper boards made from wood waste or wood pulp are sold under a variety of trade names including Upson Board and Beaver Board. Laminated paper boards should be thought of as temporary supports. They are highly acidic and have a weak physical structure, so they deteriorate quickly. Museum board is a high quality laminated paper board made of 100% cotton rag mat board. Museum boards have between two and eight distinct layers. As museum board lacks structural strength, for increased rigidity it should be mounted on a wooden auxiliary brace or panel.

Canvas Boards

Canvas boards are constructed from a thin layer of cotton or muslin primed with an acrylic dispersion ground that has been glued to a sheet of pulp cardboard. These boards should not be used if long-term preservation is a concern.

Aluminum

Aluminum panels, Aluminum Composite Material (ACM) panels, aluminum honeycomb panels, and Dibond panels have been widely used by artists since the late 1940s. Aluminum is more resistant to corrosion than other metals, can be cut easily with a band saw, and, depending on the size and thickness of the panel, will retain stiffness. It is necessary to note that, even in a stable environment, thinner pieces of aluminum will not remain planar.

ACM boards differ by manufacturer but are typically composed of a thermoplastic core sandwiched between two lightweight sheets of aluminum. These boards can be purchased with two sides of exposed aluminum and no preparatory layer, with a canvas mounted to one side and a mill (polished aluminum) finish on the reverse, or with one side coated with a white polyester coil finish to protect the surface against corrosion.

Arteflex ACM Panels are comprised of two sheets of 3mm aluminum bonded to a solid polyethylene core. They can be purchased with or without a preparatory layer and with or without one side covered with canvas. **Dibond** ACM Panels are made of two lightweight sheets of .010" aluminum with a thermoplastic core. They are available in a variety of colors.

The advantages of ACM panels over wood or stretched canvas are that they do not respond as readily to changes in RH and are not prone to insect damage.

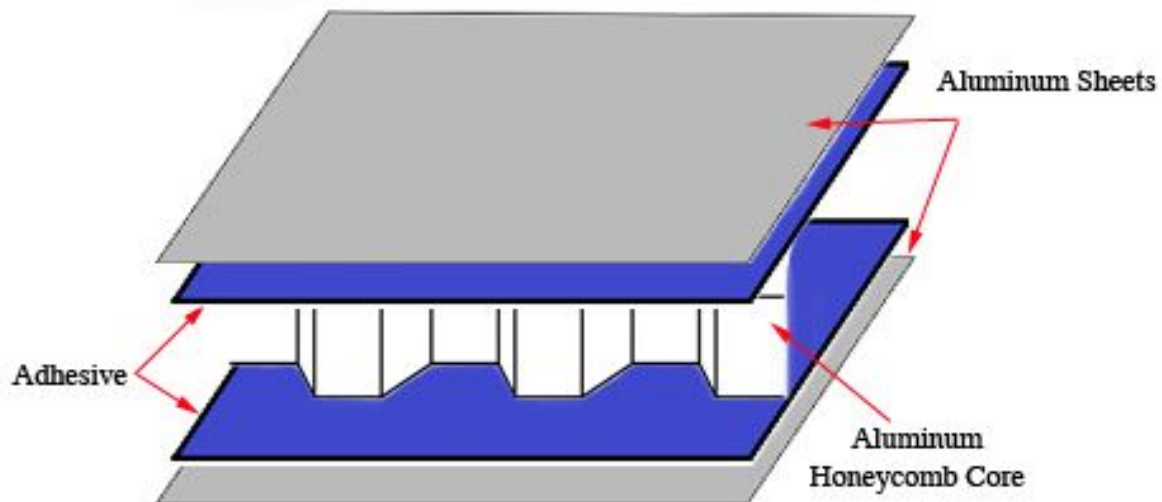


Diagram showing the typical layering structure of an Aluminum Honeycomb Panel.

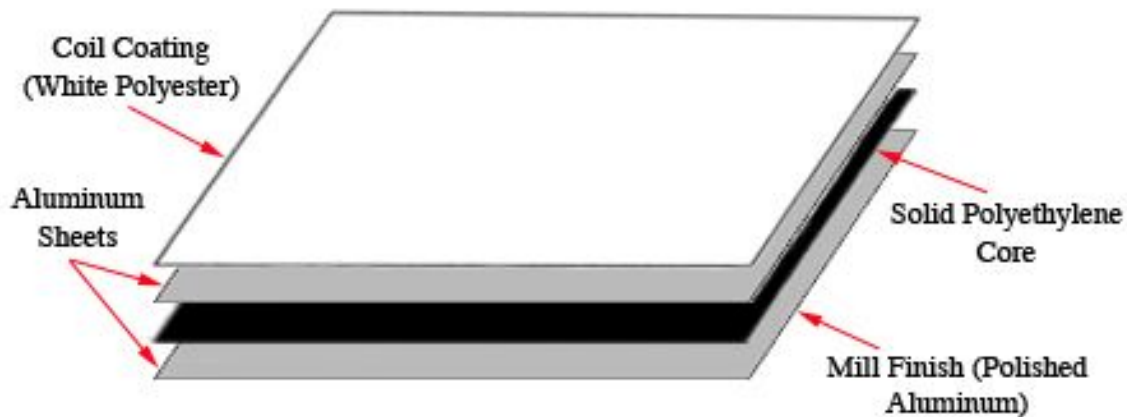


Diagram showing an example of the layering structure of an Aluminum Composite Panel (ACM).

Artists who choose to use these supports should:

- Prepare the aluminum/ACM surfaces by removing the protective film. Degreasing the presentation side (typically the side coated with polyester) with ethanol or isopropanol. Create a tooth (e.g. 100/200 grit sandpaper) by lightly roughening the surface with an abrasive material
NOTE: If a white protective polyester coil coating is present avoid breaking completely through it as this exposes the underlying aluminum and can lead to corrosion.
- Avoid ACM panels that do not have a polyester coil coating (in industry ACM panels can be coated with a range of materials).
- Choose a priming/ground material carefully. Priming/ground materials that are available in industry may be acceptable if they have been found to be compatible with certain ACM brands (Example: DTM Bonding Primer by Sherwin Williams has been found to be highly compatible with Dibond panels). As with most industry products, artists are encouraged to test these materials with their preferred painting technique.
- Fix thinner supports to more rigid supports such as Masonite or construct a cradle (see instructions below). Sheets that are too thin are more prone to damage as they may flex and twist during transportation and handling.
- Remember that “fat over lean” principles should be followed when applying alkyd, acrylics, and/or oil paints.
- Understand that ACM panels with honeycomb or corrugated plastic cores (such as Artefex) tend to be lighter in weight than ACM panels that contain solid plastic cores.
- Avoid subjecting the panel to extremely high temperatures (above 175 F).
- Know that supports that are fairly heavy are at risk of planar deformation along the outer edges (e.g. bent corners) especially during transportation and handling.

- Avoid painting directly on the surface of unprimed aluminum as this technique can lead to adhesion problems.
- Consider applying an even coat of neutral pH PVA adhesive or certain acrylic polymers (e.g. high quality acrylic dispersion mediums or gels) when adhering canvas/paper to the surface of a panel following degreasing/cleaning of the surface. To adhere your canvas to a panel, the following steps are recommended:

Apply one even coat of PVA size or acrylic gel medium to the surface of the panel using a spatula or a brush. Lightly wet the reverse of the canvas (the side that will be adhered to the panel) with water to promote better adhesion. Use a brayer/bone folder to eliminate any air bubbles, working from the center outwards to the edges. If you have decided to keep excess fabric along the outer edges, fold them over and attach to the backside of the panel (or affix them later). Immediately apply another coat of PVA size or acrylic gel medium (stick to the same material you used previously) to the face of the canvas. Once the canvas has dried, apply a coat of PVA size or acrylic gel medium to the reverse of the panel to prevent potential warping.

- Consider using BEVA 371 adhesive/film to adhere canvas to panel after the panel has been sealed. BEVA film (as opposed to the adhesive) will not penetrate the fabric support as readily as PVA adhesive or acrylic mediums might and the ability to re-activate the adhesive with heat makes it far easier to later address any unwanted air-bubbles should they form during the procedure. To adhere your canvas to a panel, the following steps are recommended:

Apply one to two even coats of dilute BEVA adhesive (thin cream consistency) to the panel after cleaning the surface and two coats to the reverse of the canvas (wear adequate protection as solvents are required). If you are using BEVA film it is better to use two sheets of film as opposed to one, although one sheet may be able to provide enough adhesion. Place the film with the BEVA-side facing the panel (or canvas if you are using two sheets) without removing the silicone-coated Mylar and apply heat evenly using an iron (BEVA adhesive requires a temperature of around 65.6 degrees Celsius to be re-activated). Weight down the surface until the BEVA has cooled and then carefully peel away the silicone-coated Mylar (NOTE: If you attempt to remove the Mylar too soon you will pull up the BEVA). If you are using two sheets, repeat this process with the other sheet of BEVA film when applying to the reverse of the canvas support (consider placing silicone-release paper/Mylar beneath the canvas when applying heat, silicone side facing up). Then position your canvas directly atop the BEVA film,

place silicone-release paper/Mylar (silicone side facing down) atop the canvas, and apply heat. If you are using BEVA adhesive simply wait for the coats of BEVA to dry (in a well ventilated space) and repeat the aforementioned step. If you experience difficulties using BEVA film, try applying a coat of adhesive to the back of the canvas or switch to the adhesive altogether. Consider using a temperature controlled vacuum table if you wish to adhere a completed painting onto a panel (in general this is not recommended). It *may* be possible to safely adhere your composition if it does not contain thickly built up paint, wax-based additives, or areas of strong impasto. Follow the instructions above but consider using a soft blotter paper over your silicone release paper/ Mylar to protect more delicate surfaces (you may also need to raise the temperature of your iron ever so slightly).

- Provide additional auxiliary support to large format panels and panels that are less than $\frac{3}{4}$ " thick by attaching a brace or cradle by gluing strips of wood around the outside edge of the back of the panel using the following steps:

Obtain 1" by 2" wooden boards (oak or maple are preferred) and cut them down to match the outer dimensions of the support (overall size will depend on what type of join is used for the corners). Butt and mitered tend to be the most common type of joins (consider using a 90 degree-corner clamp when making mitered corners), however lap joins are generally considered to be more structurally sound. Make sure that the wooden boards are perfectly aligned and flush with the outer edges by laying them on the reverse of the panel before gluing to the reverse (it can helpful to mark the position with a pencil). Use an appropriate adhesive (please refer to the Dibond Manual located in our reference section) to adhere the wooden boards in place while the glue is drying, clamp/weight the boards to avoid creating any air bubbles. For large-scale supports artists may choose to construct horizontal and/or vertical crossbars although crossbars should NOT be glued directly to the reverse of the panel, only fixed to the outer boards of the cradle using glue and/or hardware.

Copper

Artists have used copper supports since the 17th century for both practical and aesthetic reasons. Copper panels are durable and compact and are available in a range of portable sizes but are more prone to corrosion than aluminum. A copper support tends to give a warm tone to the overall composition as oil paints do not

sink into the ground as they do on canvas or wooden panels so they can remain intensely saturated even when applied in thin layers.

Artists who choose to use copper supports should:

- Prepare the surface by degreasing the presentation side with solvents (e.g. mineral spirits followed by denatured alcohol) and creating a tooth by roughening the surface with an abrasive material. NOTE: There is no need to purchase costlier “polished” copper etching plates as artists are encouraged to abrade the surface anyhow to improve adhesion.
- Sheets that are too thin are more prone to damage as they can flex and twist during transportation and handling. Select copper panels that are of an appropriate thickness (e.g. high quality copper etching plates).
- Fix/adhere thinner supports to more rigid supports such as Masonite by globally applying an adhesive like epoxy in an even manner to the sheet and/or the rigid support (abrade the reverse of the panel prior to gluing to improve adhesion). In general, however, thin gauge copper panels should be avoided.
- Remember that “fat over lean” principles should be followed when applying alkyd, acrylics, and/or oil paints.
- Avoid aqueous-based ground/paint materials in order to prevent the formation of corrosion products.
- Not paint directly on the surface of unprimed copper as this technique may lead to potential adhesion problems in the future.

Other Metal Supports

Tin, tin-plated iron, steel, zinc, and other metals have occasionally been used by artists as supports. **Tin-containing** supports are susceptible to corrosion when exposed to high humidity, oxygen, and atmospheric pollutants. **Zinc** supports are less prone to corrosion in humid environments than copper supports, but they are more susceptible to degradation when exposed to acidic or alkaline materials and conditions. A thin transparent film of zinc oxide (which appears as a bluish-white film) can form on a zinc panel when it is exposed to air. The zinc oxide then can react with fatty acids in oil and alkyd paints to form zinc soaps (which may protrude through the surface as unsightly pustules). **Steel and stainless steel** are not commonly used as supports due to the weight of these metal alloys. Steel is composed of iron and carbon with smaller additions of other metallic elements such as molybdenum, manganese, copper, chromium, or nickel. The larger percentage of chromium in stainless steel (a minimum of 10.5% by mass) is what gives it corrosion resistance.

Slate/Stone/Marble/Porphry

It is likely that various stones have been used as painting substrates since antiquity. Stones or marbles that have a fine grain (are not porous) and can be evenly polished are the most suitable for use as painting supports. Stone supports are mechanically stable as they do not change with humidity fluctuations and are impervious to worms and insects. Brittleness, poor preparation of the surface, and poor application of the paint and ground layers (e.g. deviating from the fat over lean principle) can cause delamination.

Glass

Glass supports share the mechanical stability and insect resistance of stone supports, but possess a highly finished, non-porous surface. However, glass is inherently fragile and prone to breakage (particularly around the outer edges) and can become more brittle as it ages. As paint and ground layers can readily delaminate due to the slick surface, glass supports are not recommended. If artists choose to use glass supports, only frosted or sandblasted glass should be used and the surface should be degreased with ethanol or acetone before use.

Polyvinyl chloride (e.g. Sintra)

The main issue with the use of polyvinyl chloride-based plastics as painting supports is the presence of plasticizers and other additives which are added during the manufacturing process. Without testing, it is difficult to identify the specific polymer blends present within a polyvinyl chloride (PVC) sheet or to know how stable the material is. Over time, the plasticizers in a PVC sheet can migrate to the surface forming visible liquid drops which become tacky and then crystalline. The migration of plasticizers will likely cause delamination of the paint and/or ground layers. Sheets of PVC can warp and will sometimes grow mold when exposed to high levels of humidity and heat. Polyvinyl chloride is not recommended as a permanent support for works of art.

If the artist insists on using a PVC support, the best procedure is to paint on a properly primed canvas and adhere the finished canvas to the plastic sheet. This way, if the plastic support deteriorates, the canvas can be removed and adhered to new support.

Polycarbonate (e.g. Lexan)

Like polyvinyl chloride-based plastics, polycarbonates also tend to contain a wide range of additives that can pose potential problems for artists. Polycarbonates are long-chain linear polyesters of carbonic acid and dihydric phenols (e.g. Bisphenol A). There are several grades of polycarbonate sheeting available today and distinguishing one from another really depends on the additives present which can include glass fibers, UV stabilizers, mold release agents, and flame retarders. The presence/absence of these stabilizers will in turn affect the polycarbonate's resistance to heat, its brittleness, and its tendency to degrade in UV light.

Polycarbonate can also be incredibly sensitive to certain solvents; artists should avoid bringing acetone, aromatics, and other solvents to surface of Plexiglass, sticking instead to water or mineral spirits-based products.

The primary concern regarding these additives is their tendency to migrate out of the substrate slowly over time (or quickly depending on the nature of the environment). For example, the migration of Bisphenol-A in clear polycarbonate plastics (e.g. water bottles) has been extensively studied, a phenomenon that could very likely cause delamination and/or flaking of the overlying ground/paint layers. It is for this reason that polycarbonate supports are not recommended for artworks that are intended to last.

Polymethyl Methacrylate (e.g. Plexiglas)

Plexiglass is one of several trademarked names used to market clear sheets of polymethyl methacrylate, a material that is a popular support among artists. These sheets tend not to contain potentially problematic additives such as those found in polyvinyl chloride- and polycarbonate-based materials. However, Plexiglass will expand and contract in response to changes in temperature and humidity, leading to eventual warping or bending of the support. This can be problematic if very brittle materials are used in the paint and/or ground layers (e.g. oils, alkyds, certain resins) as delamination and cracking may occur as the support expands and contracts. Watercolors, tempera, and most gouache paints should be avoided. The glassy-like surface of Plexiglass makes for a surface that can be easily scratched and can build up a static charge that can attract dust particles. Plexiglass is prone to yellowing if exposed to UV light and can be extremely sensitive to certain solvents; artists should avoid bringing acetone, aromatics, and other solvents to surface of Plexiglas, sticking instead to water or mineral spirits-based products. Finally, and perhaps most importantly, Plexiglass supports are inherently brittle and easily shatter or crack if dropped or damaged.

If an artist insists on using a polymethyl methacrylate support, the best procedure is to initially sand the surface in order to provide some mechanical tooth to improve the adhesion of the paint and ground layers. Artists should consider painting and priming with acrylics if using Plexiglass as they do retain some degree of flexibility. Avoid installing inflexible hardware directly into the Plexiglass, choose thicker rather than thinner sheets, and use a channeled frame to house/display the Plexiglass.

ADDITIONAL REFERENCES AND RESOURCES

General

“Supports” in *The Painter's Handbook: Revised and Expanded* by Mark David Gottsegen (New York: Watson-Guption, 2006).

“History and Use of Panels or Other Rigid Supports” by Jorgen Wadum and Noelle Streeton in *The Conservation of Easel Paintings*, eds. Dr. Joyce Hill Stoner and Rebecca Rushfield (London and New York: Routledge, 2012).

Golden Artist Colors - Preparing a Painting Support
http://www.goldenpaints.com/technicalinfo_prepsupp

CAMEO: Conservation and Art Materials Encyclopedia Online (Museum of Fine Arts Boston) http://cameo.mfa.org/wiki/Main_Page

Wood

Kress Technical Art History Website - Wooden Supports
<https://www.artcons.udel.edu/about-us/kress/historical-materials-techniques/wooden-supports>

Golden Artists Colors - *Understanding Wood Supports for Art - A Brief History* by Elaine Salazar
<http://oldsite.goldenpaints.com/justpaint/jp29article3.php>

Britannica – Wood Science <http://www.britannica.com/science/wood-plant-tissue>

Transport Information Services – Properties of Various Wood Species
http://www.tis-gdv.de/tis_e/misc/holzart.htm

The Encyclopedia of Wood, U.S. Department of Agriculture, 2007 [portions available]
https://books.google.com/books?id=qxQnAgAAQBAJ&pg=PT354&lpg=PT354&dq=%E2%80%A2+The+Encyclopedia+of+Wood,+USDA&source=bl&ots=MYUmCSV66b&sig=xUESVua9_cPCeLrPxf08t7N_2fQ&hl=en&sa=X&ved=0ahUKewjard7PxZn0AhUCNSYKHbvzBaMQ6AEIcjAJ#v=onepage&q=%E2%80%A2%20The%20Encyclopedia%20of%20Wood%2C%20USDA&f=false

Hardboard, Fiberboard, etc.

Journal of the American Institute for Conservation (JAIC) - “Short communication early wood-fiber panels: Masonite, hardboard, and lower-density boards” by Alexander W. Katlan
<http://cool.conservation-us.org/jaic/articles/jaic33-03-005.html>

Golden Artists Colors - Plywood as a Substrate for Painting
<http://oldsite.goldenpaints.com/justpaint/jp29article4.php>

Ampersand - Painting Panels for Artists
http://www.ampersandart.com/products_main.html

American Harboardt Association - Today's Hardboard

<http://domensino.com/aha/images/tdyhdbrd.pdf>

Composite Panel Association

<http://www.compositepanel.org/>

Composite Panel Association - MDF From Start to Finish

http://www.hardwoods-inc.com/sites/default/files/mdf_start_to_finish_2005.pdf

“Wood-based Composites and Panel Products” by John A. Youngquist in Forest Products Laboratory *Madison, WI: I.S. Department of Agriculture, 1999)

http://www.carbeck.org/pdfs/FPL_Wood_Handbook_Ch10.pdf

Panel Processing, Inc. – “Hardboard (Masonite) What is it?” by RM Granum and O.B. Eustis https://harborsales.net/Portals/0/docs/hardboard_what_is_it.pdf

Aluminum

Dibond Fabrication Manual

http://graphicdisplayusa.com/downloads/Dibond%20Fabrication%20Manual_May%202011.pdf

Graphic Display, USA - Dibond

<http://graphicdisplayusa.com/products/dibond/>

Natural Pigments - Artefex ACM panels <http://www.naturalpigments.com/custom-arteefex-panel.html>

Jackson's - Aluminum Painting Panels

<https://www.jacksonsart.com/blog/2014/03/28/aluminium-painting-panels/>

SOS Graphics – Substrate List <http://www.sosgraphics.ca/SOSMaterialList.pdf>

Copper

Copper as Canvas: Two Centuries of Masterpiece Paintings on Copper, 1575–1775, ed. by Michael K. Komanecky (Oxford: Oxford University Press, 1998).

Plastics, etc.

Golden Artist Colors – Acrylics on Plastics <http://www.justpaint.org/acrylics-on-plastics>

SOS Graphics Substrate List <http://www.sosgraphics.ca/SOSMaterialList.pdf>

Polycarbonates and other plastics

http://www.ptslc.com/intro/polycarb_intro.aspx

Plexiglas

<http://www.plexiglas.com/export/sites/plexiglas/.content/medias/downloads/sheet-docs/plexiglas-general-information-and-physical-properties.pdf>

Plastics in Art: A Study from the Conservation Point of View, by Friederike Waentig (Petersberg: Imhof., 2008).

Plastics in Art: History, Technology, Preservation, by Thea van Oosten, Yvonne Shashoua, and Friederike Waentig (Munich: Siegl, 2002).