

Six Essential Glues

BY SCOTT GIBSON

PVA

Versatile workhorse good for general assembly work and joinery

These adhesives handle most furniture-making needs



POLYURETHANE

Ideal for laminations, edge joints, and outdoor furniture

EPOXY

Good for laminations, outdoor furniture, and when a structural gap-filling bond is needed

CYANOACRYLATE

Best for quick repairs of defects, such as cracks, small knots, and slivers



UREA FORMALDEHYDE

Good for veneering
and bent laminations

When I first started making furniture, I thought the chances of glue alone holding a piece of furniture together were pretty slim. Wouldn't it be a good idea, I wondered, to sneak in a few nails or screws to reinforce joints that otherwise would surely fail? But I learned that woodworking joints don't fail very often, and when they do, it's usually not the glue that's to blame.

Most woodworkers have their favorites, but few rely on a single type of glue, and for good reason. The many glues to choose from have characteristics that make them especially well suited to one job or another. Taking into account a wide range of woodworking applications, I've chosen six types of glue that will be useful in many shops: polyvinyl acetate (PVA) or yellow glue, polyurethane, two-part epoxy, cyanoacrylate, hide (both forms, dried and liquid), and urea formaldehyde (both types, one-part and two-part).

The bonding strength of each glue is derived from standard industry tests and ranges from 2,500 to 4,000 psi in shear. All of the glues are more than strong enough for general woodworking and furniture making, so to determine your choice, consider other properties such as shelf life, open time, clamp time, structural gap-filling properties, and pot life. Open time is the length of time that glued components can be left open to the air before they must be assembled. Each glue has a limited shelf life, which can be shortened by exposure to air, moisture, or

heat. How long glue can sit around and still work as advertised varies from six months to several years. Two-component glues such as epoxy and urea formaldehyde also have a pot life, or the amount of time that the adhesive remains usable when left in its mixing container.

All glues differ in their levels of toxicity; if in doubt, get a Material Safety Data Sheet (MSDS) from the manufacturer for more information (these documents also are accessible on the Web).

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HIDE GLUE

Excels at veneering and
repairing period furniture
and musical instruments

PVA

The reliable shop workhorse

BEST USES	General furniture making and woodworking
OPEN TIME	5 to 10 minutes*
CLAMP TIME	30 to 60 minutes, depending on humidity, temperature, and wood species
WATER, HEAT, AND SOLVENT RESISTANCE	Water resistance varies; standard formulations lose 50% of strength at 150°F; good solvent resistance
CLEANUP	Water
HEALTH AND SAFETY	Low toxicity; however, the small amount of vinyl acetate in yellow glue is considered a possible human carcinogen when inhaled
SHELF LIFE	1 to 4 years
COST	About \$5 for 16 oz.

*Some specialized formulas offer longer open times.



Apply PVA to mating surfaces. Once a mortise-and-tenon has been dry-fitted, use a stick to apply glue on the mortise walls.



Work quickly. PVA has a short open time. Once you've applied glue to all of the appropriate surfaces, promptly assemble the joint.



Yellow glue (also known as PVA glue) comes close to being an all-purpose adhesive for furniture making. Clamp times are short, and the glued-up components can be worked on in an hour or less if you're careful.

Yellow glue is great for biscuit joinery because the water in the glue swells biscuits rapidly and locks them in place. Yellow glue also is good for snug assembly joints, such as dadoes, mortise-and-tenons, and dovetails. Cured yellow glue has a certain amount of plasticity, which allows the wood in the joint to expand and contract without fracturing the bond line. Although the glue can fill small hairline gaps, joints must fit well overall for a strong bond.

Yellow glue is ideal for rub joints, in which a workpiece is glued in place simply by coating one surface and sliding the wood back and forth to create a vacuum—no clamps are needed. Yellow glue also acts as a lubricant while

assembling dovetail joints. Apply yellow glue to the inside surfaces of the tails and to the top inside edges of the pins and then slide the joint together.

For all of its positive attributes, yellow glue has a few drawbacks. Standard formulations don't have much water resistance and can creep—that is, slowly stretch under long-term loads. That's why yellow glue is a poor choice for bent laminations whose members will be highly stressed.

Also, yellow glue has a short open time, which can be problematic. For instance, during big, complicated glue-ups, there may not be enough time to align and adjust all of the parts and pieces before the glue starts to set.

Uncured yellow glue cleans up with water. However, using water to clean up squeeze-out can fill pores with diluted glue and interfere with the finish. It's better to wait until the glue becomes rubbery and then scrape it off. Prior to applying a finish, dampen a rag with acetone or denatured alcohol and wipe areas where squeeze-out was removed to reveal any remaining glue, which then can be scraped off easily.

Not all yellow glues are created equal. There is a wide choice of formulations, with various grades of water resistance and chalk temperatures—the point at which the glue no longer bonds. If yellow glue turns white on a workpiece, it means the shop temperature probably has fallen below the glue's chalk temperature, and the bond will not be reliable.



Wait for the glue to set. Squeeze-out is best removed after about 30 minutes, before the glue gets too hard.

Polyurethane

Long open time and good water resistance

BEST USES	Complicated assemblies; laminations, flat or bent; bonding hardware; outdoor furniture
OPEN TIME	15 to 20 minutes
CLAMP TIME	4 to 6 hours
WATER, HEAT, AND SOLVENT RESISTANCE	High water, heat (up to 360°F), and solvent resistance
CLEANUP	Soap and water, acetone, or denatured alcohol
HEALTH AND SAFETY	Contains polymeric MDI, a strong sensitizer that may provoke allergic reactions; stains skin; do not use if you have asthma or other chronic respiratory problems; work in a well-ventilated area; wear protective gloves and safety glasses
SHELF LIFE	1 year
COST	About \$13 for 16 oz.



As it dries, polyurethane glue expands into a messy pale brown froth, so don't use any more than you have to. Although it will fill minor voids, the glue doesn't have structural gap-filling properties. The best way to clean squeeze-out is to wait until the glue is thoroughly dry, then scrape or chisel away the excess.

With its long open time, polyurethane often is the first choice for complicated glue-ups involving many parts and pieces. Thanks to its high water resistance, polyurethane can be used with confidence outside. Also, it's good for bonding dissimilar materials.

Polyurethane is more creep resistant than yellow glue, so it's a good choice for gluing up laminations, bent or flat. It also works well in edge joints because it forms a thin glueline.

Polyurethane also can stain the skin, so be sure to wear a pair of latex gloves when using it. Another disadvantage is cost. Polyurethane is more expensive than yellow glue, but its bond strength is roughly the same.

Without moisture, a glue joint made with polyurethane may fail. Polyurethane works best on wood with a moisture content of 10% to 25%. In general, dampen the surfaces of the assembly with water a few minutes before applying the glue.



Moisten mating surfaces. Polyurethane glue needs moisture to cure, so use a damp cloth to wipe down both surfaces if using hardwood.



Apply glue sparingly. Polyurethane glue creates a very thin bond line, but squeeze-out will foam up when exposed to air.



Wait six to eight hours before cleaning up squeeze-out. Once hardened, polyurethane foam is removed easily with a chisel.

Epoxy

Versatile, gap-filling, and waterproof



from a fast hardener to a slow hardener can double the glue's pot life. Heat also can play an important role in altering the working properties of epoxy. Higher temperatures speed cure times, and cooler temperatures slow them down. Another advantage of epoxy is that you can add thickening agents to help the glue fill gaps and to make it less likely to drip.

Like polyurethane, epoxy has a long open time, making it ideal for lengthy and complex glue-ups, such as case pieces.

Epoxy doesn't shrink when it dries and so is the best glue to use when structural gap-filling properties are needed: It can be used to repair damaged wood or to compensate for badly fitting

parts in new construction.

Fast-setting five-minute epoxy is especially suited to filling gaps. Mixed with sawdust, five-minute epoxy can be used to fill holes and can be colored to match a stain or tint. However, it does have a lower shear strength than conventional epoxy.

Exposed to temperatures below 200°F, epoxy doesn't exhibit much creep, so it can be used to form bent laminations in furniture. Keeping individual plies as thin as practical will help reduce stress in finished

BEST USES	Complex glue-ups; outdoor furniture; bonding hardware; structural gap-filling repairs
OPEN TIME	Pot life of 4 to 50 minutes; depending on the temperature and type, open time of 5 to 30 minutes
CLAMP TIME	45 minutes to 15 hours
WATER, HEAT, AND SOLVENT RESISTANCE	Impervious to water; stable in temperatures under 200°F; susceptible to softening with continuous exposure to alcohol, acetone, or lacquer thinner
CLEANUP	Lacquer thinner, acetone, denatured alcohol
HEALTH AND SAFETY	Skin contact with resins and hardeners can cause chronic health problems; avoid inhaling vapors of uncured epoxy; never breathe dust from partially cured epoxy; wear gloves, safety glasses, and a respirator while mixing
SHELF LIFE	At least 3 years for the resin; 2 years for the hardener
COST	About \$19 for 16 oz.

Two-part epoxy is a finicky glue but offers a kind of precision and predictability that no other woodworking glue can match. Epoxy is a thermoset plastic that cures to a solid as the result of a chemical reaction between a resin and a hardener when these contents are mixed.

Epoxy is versatile, and you can alter the mixture as circumstances require. With a range of different resins and hardeners, you can change open and cure times as well as the viscosity of the glue. Switching



A two-component glue. The pumps on the resin and hardener make it easy to measure the right amounts every time.



Ideal for oily woods. Epoxy will provide good bonding and plenty of strength for this lap joint made with teak stock.



Metal meets wood. Epoxy forms a strong bond between dissimilar materials.



Filling knots with sawdust and five-minute epoxy. Not only does the glue secure the knot, but also it fills the gap and will accept tints and finishes.

components, such as a stretcher on a table or chair or a curved handle.

Cured epoxy is unaffected by water, making it the glue of choice for projects that will be exposed to water, such as in boatbuilding. Epoxy also excels at bonding dissimilar materials, such as aluminum or steel to wood; some brands are specially formulated to work on oily woods such as teak and rosewood.

On the downside, epoxy is expensive and unforgiving. Its resin and hardener components must be proportioned exactly and mixed carefully. Even though metered pumps make mixing easier, they waste glue when you need only a very small amount.

Cyanoacrylate

Small jobs at warp speed

Cyanoacrylates are special-purpose adhesives. They are not designed as all-purpose woodworking glues, but they do create an almost instantaneous bond between porous surfaces. That makes them useful for repairing cracks, bonding small knots, and reattaching slivers of wood. And you can work the wood immediately after the repair. The fast bonding times of cyanoacrylates allow them to be used to attach temporary glue blocks to hard-to-clamp furniture components, such as chair parts. Apply cyanoacrylate to a block of softwood, spritz the chair part with an accelerator, and stick the two together. When the blocks are no longer needed, break them away with a rap of a hammer.

Cyanoacrylates are available in several viscosities. They cure with the help of moisture in the wood and work at just about any temperature. Open times are extremely short, but lower temperatures lengthen the curing time. Although parts are firmly bonded after the glue is applied, a full cure takes overnight.

Keep a bottle of a proprietary debonder or acetone on hand for when the cyanoacrylate glue gets on your fingers. Debonder will soften hardened glue and allow attached items to be pulled apart.



BEST USES	Quick repairs of small pieces; glue blocks for temporary clamping
OPEN TIME	Less than 1 minute
CLAMP TIME	Less than 1 minute
WATER, HEAT, AND SOLVENT RESISTANCE	Low water resistance; begins to soften at 200°F; softens with exposure to acetone
CLEANUP	Proprietary debonder or acetone
HEALTH AND SAFETY	Avoid contact with skin and eyes; breathing fumes at high concentrations may irritate eyes, nose, and lungs; wear protective gloves and safety glasses
SHELF LIFE	1 year; longer when stored in a refrigerator
COST	About \$10 for 2 oz.



Cyanoacrylates need very little setting time. Within a minute of making a quick repair, you'll be able to go back to work.



Accelerators speed up the already fast-bonding glue. No clamps are needed when using an accelerator.

Hide Glue

Preferred by traditionalists

BEST USES	Applications where reversibility is an advantage, such as musical instruments, period furniture, and hammer veneering
OPEN TIME	10 minutes for liquid; temperature-dependent for dried
CLAMP TIME	Up to 12 hours for liquid; less for dried
WATER, HEAT, AND SOLVENT RESISTANCE	Low moisture and heat resistance, excellent solvent resistance
CLEANUP	Water
HEALTH AND SAFETY	Relatively low toxicity; can cause skin irritation; dust inhalation may irritate throat and respiratory track
SHELF LIFE	Indefinite for dried glue, unless exposed to moisture; 1 year for liquid form
COST	About \$10 for 1 lb., dried; about \$9 for 10 oz., liquid

Unlike any other woodworking adhesive, hide glue is prized for its ability to come apart as much as it is for holding pieces together. Cured hide glue makes a long-lasting bond that resists solvents, but it has low resistance to moisture and heat. Because the bond can be coaxed apart with water and heat to allow for repairs, hide glue is the choice of many woodworkers who build or repair period furniture and musical instruments. Hide glue also is used for hammer veneering, a traditional hand technique that doesn't require a vacuum, clamps, or presses (see the photos at right).

Hide glue, a protein-based adhesive made from cow hides, is available in a ready-to-use liquid or in a dried form that must be mixed with water and heated before it can be used.

Dried glue comes in pearl or ground form, with the latter generally being of better quality; pearl glue is sometimes made from bones instead of hides. Open times can be lengthened or shortened by increas-



Dried hide glue needs water and heat. A dedicated glue pot will keep the glue at the optimum temperature of 140°F.



Hide glue starts to set as it cools. Apply glue on both bonding surfaces, the substrate (above) and the underside of the veneer.

ing or lowering the temperature and by altering the proportion of water to glue. Also, adding urea, a gel depressant available at garden-supply stores and online, increases open times but weakens the glue.

Hide glue can be heated and cooled a number of times before it should be discarded (you'll know when it's time by the bad odor caused by bacteria). Bacteria growth can be inhibited by adding 0.1% household bleach.

Liquid hide glue, which contains urea, stays in liquid form at room temperature, making it easier to use than the dried form. It has a shelf life of about one year (look for a date on the label or on the container itself). When in doubt, try gluing together two blocks of wood and then banging them apart with a hammer. If the bond is hard to break, the glue is fine.



Rub the veneer with a veneer hammer. The glue on the veneer acts as a lubricator. Starting from the center outward, apply steady pressure with the edge of the hammer.

Urea Formaldehyde

Performs well under stress

BEST USES	Veneering; bent laminations
OPEN TIME	Pot life of several hours; depending on temperature and mix, open time of 5 to 30 minutes
CLAMP TIME	Up to 13 hours for one part powdered; up to five hours for liquid
WATER, HEAT, AND SOLVENT RESISTANCE	Excellent solvent and water resistance; unaffected by heat up to 180°F
CLEANUP	Water
HEALTH AND SAFETY	Contains formaldehyde, a skin and lung irritant and a possible human carcinogen; wear protective gloves, safety glasses, and a respirator while mixing and using
SHELF LIFE	Up to 1 year; decreases in warm temperatures
COST	About \$6 for 1 lb., dried; about \$30 for 1 gal., liquid



and as a two-part adhesive consisting of a powdered catalyst and a liquid resin. Both types take a relatively long time to cure and need shop temperatures of at least 65°F to work properly. Ideally, wood should have a moisture content of between 6% and 10% for the one-part type and between 6% and 15% for the two-part type.

Like epoxy, urea formaldehyde is dramatically affected by temperature. According to one manufacturer, DAP Inc., pot life is four hours at 70°F but only about 30 minutes at 100°F. At 70°F, the clamp time is 13 hours, but it drops to five hours at 90°F.

Urea formaldehyde is more toxic than many other glues. Formaldehyde is a possible human carcinogen. It's also an irritant to the skin and lungs and a skin sensitizer that can lead to dermatitis with repeated

contact. You should wear a respirator and protective gloves when mixing and using this type of glue.

The sale of urea-formaldehyde glue is prohibited by a small number of local authorities around the country. If you want to find out whether the glue is permitted in your area, call DAP Inc. at 888-327-8477.

Urea-formaldehyde glue has a long pot life and yields a rigid, high-strength bond that resists water and solvents, making the glue especially good for bonding wood veneer and gluing bent laminations. Gluelines won't creep and should not be affected by temperatures up to about 180°F.

Urea formaldehyde is available as a pre-catalyzed powder that's mixed with water



Prepare water and powder quantities separately. Add powder to a portion of the water, then add the remaining water.



Apply a thin layer of glue. When gluing up laminations, apply glue to only one face of each piece.



Clamp from the center out. When clamping the glued-up lamination, apply the clamps sequentially from one point outward.