

ADHESIVE DEMONSTRATION

By Stan Stephens

“Woodworking isn’t a cheap hobby, but glue isn’t the problem.”

Glossary:

Pot Life - The maximum amount of time you have to apply two-component glues to your work after they have been mixed. Think epoxy or Urea formaldehyde adhesives.

Open or working time –This is the amount of time you have between spreading the glue and assembling the joint (but not necessarily clamping yet). Once the glue is spread, the water begins to evaporate and the glue begins to skin over.

Working or assembly time – The amount of time between applying the glue and the point at which the work piece should no longer be manipulated is known as the “assembly time.” This time starts once the two glue surfaces are touching, and tells you how long you must get the pieces aligned and clamped before the glue begins to set-up.

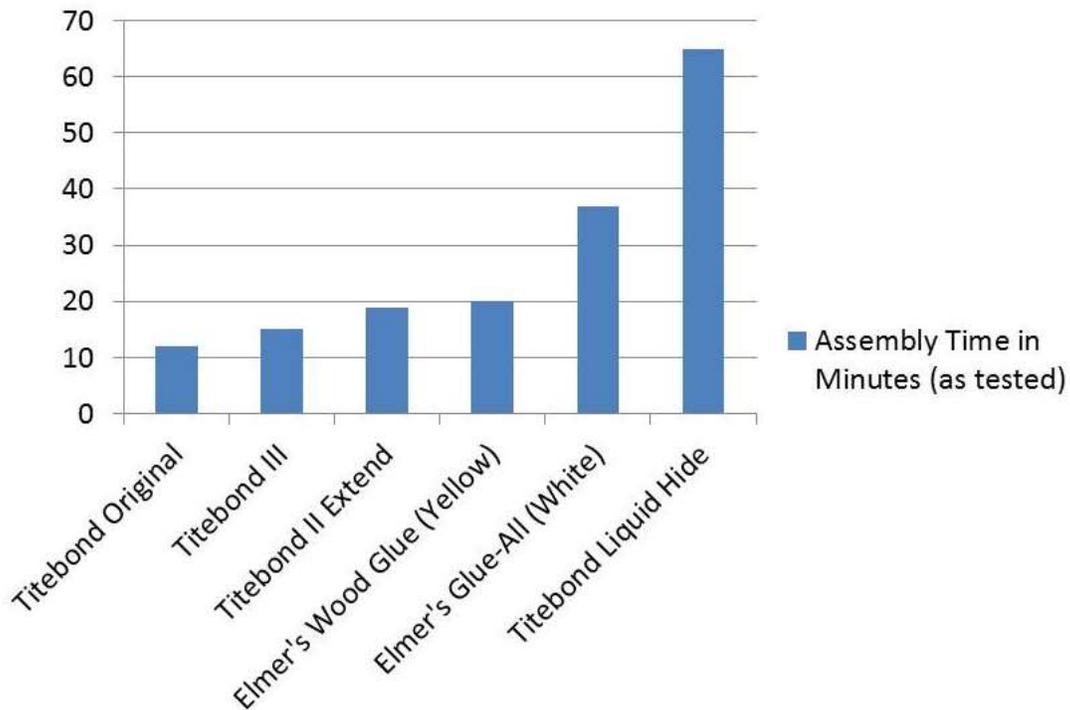
Environmental factors, such as temperature, humidity, wood species, grain patten, and size of the gluing area can affect assembly time. A warmer, dryer shop will speed up the clock. The manufacturer specifications are based on an environment where the humidity is mid-range and the temperature is 72-degree.

- ✓ **Fast:** Hot hide glue tacks in minutes. CAs bond “instantly,” but with the aid of an accelerator. If you can afford a few minutes, fast-curing epoxies cure in minutes, but offer considerable strength. Hot glue is another alternative. Titebond makes a fast set glue (2–4-minute open time).
- ✓ **Slow:** Titebond III and liquid hide glue offer more time for complex or multi-stage glue-ups. For even more time, try Titebond Extend. Polyurethane glue allows a comfortable working time for complicated glue-ups, but keep the clamps on until final cure or the foam can cause joints to open. You can double epoxy’s working time with slower hardener. (Lowering the temperature in the refrigerator will also buy more time.)

Clamping time - The minimum amount of time required before you can remove the clamps from a glue-up assembly. If a joint is under stress, maintain clamping pressure for the full cure time.

Cure time - The time it takes for a glue joint to achieve full 100% bonding strength

Average Assembly Times for Various Wood Glues



Color when dry – Depending on application, this may be an issue you want to consider. Using a dark colored glue (Titebond III) on light colored wood joinery (i.e. maple) could result in the seam showing the glue. However, this would be an appropriate glue for walnut.

Shelf life - "Shelf life" is a conservative estimate of the minimum time period that we would expect a given product to remain usable, when stored as directed. This concept might also be called "useable service life" or "storage life," and it necessarily refers to both the physical handling properties and the ability of the product to perform properly. When used in reference to wood glues, reaching the stated shelf life does not mean that a product will "expire" or become unusable. Instead, the stated shelf life of most PVA glues is merely as a guideline to avoid potential aging concerns. So long as products like Titebond Original, Titebond II and Titebond III remain fluid, without a drastic change in appearance, they will continue to perform as intended. Excessive heat (higher than 85 degrees or lower than 55-degrees), humidity, or repeated freeze/thaw will cause glues to spoil prematurely.

How to tell when glue has gone bad. If the glue gels or becomes stringy or turns color, it's probably gone bad and needs to be tossed. Rub the glue between your fingers. If it feels gritty, it's gone bad. Test by gluing two boards together, allow to cure and then try breaking the bond. The wood should break, not the glue joint.

Gap Filling - If a joint is slightly less than perfect, you may not need to worry. As long as 50% of the joint faces are in contact, most glues will hold tight. (In such cases, consider leaving the clamps on through full curing to keep mating surfaces as snug as possible.) Bad craftsmanship and poor clamping

practices are another story. If you have a bridle joint with visible gaps, or a tenon that slides around within its mortise, you need a gap-filling specialist.

- ✓ **Avoid:** Polyurethane glue. It foams as it cures, but the dry froth has no significant strength. PVA might also seem like a quick fix, but that gap-filling puddle will shrink as it dries. In both cases, the adhesives create a film that seals the cell walls, complicating a future fix. (PVAs work if you can pack the joint to establish direct wood-to-wood contact.)
- ✓ **Try:** Epoxy is the best choice for structural, gap-filling repairs.

Manufacture Date – Titebond changed their manufacture date coding beginning in 2019. The first letter is A for made in America, the first two digits after the A is the last two digits of the year of manufacture, the fourth and fifth digits represent the month, the sixth and seventh digits represent the day of the month and the last three digits represent the batch number for that day. Example:
A190615023 – This material was manufactured on June 15, 2019

Flexibility/creep – A little plasticity is necessary to allow some wood movement, but slipping or stretching (often the result of constant long-term loads) that doesn't snap back is called creep. PVA glues are flexible, which is an advantage when gluing joints where there is cross grain wood movement. On smaller projects, creep means visible glue lines and laminations that lose their shape. On larger structures, creep can spell joint failure.

- ✓ **Avoid** – White glue. It creeps the most, but most PVAs can stretch under long-term stress.
- ✓ **Try** – Urea formaldehyde and epoxy are the safest choices, but polyurethane is more convenient and suitable for non-structural projects. Titebond Extend offers the best creep resistance in the PVA category. CA bonds are stiff to the point of being brittle. The bond can be broken with a tap. Preventing creep is one area where hide glue excels.

Toxicity – Some adhesives contain chemicals that can irritate eyes, nose, lungs, and skin. You need to work in a well-ventilated environment. Consider wearing gloves, goggles, and a respirator.

- ✓ **Avoid:** Urea Formaldehyde contains formaldehyde, a skin, lung, and eye irritant. Polyurethane and epoxies contain sensitizers that can trigger allergic reactions. CA fumes irritate the eyes, nose, and lungs.
- ✓ **Try:** PVAs. These are non-toxic and clean-up with water. Hide glue is another safe alternative. Hot glue works for temporary joinery.

Squeeze-out – While you want to see a little squeeze out, don't overdo it. How do you deal with squeeze-out? Do you wipe off the glue with a damp cloth or wait for the glue to set and scrape it off?

GENERAL ADHESIVE CATEGORIES

General thoughts:

Adhesives are one of the most important aspects of wood working.

Titebond original or white wood glue is the workhorse in most woodshops. However, there are some things you should be aware of. Above 120-degrees Fahrenheit white and yellow glue loose about 50% of bonding strength. That means a glued joint (especially one under stress) can come loose under adverse conditions.

PVA glues remain soft and flexible even after they have cured. They never get hard (remain soft) and allow creep (wood movement). That's not necessarily bad and desirable in some situations (cross grain joint). However, in situations where you have a flush joint or veneered seam, this may be undesirable and you may want to choose another adhesive.

They are susceptible to moisture and heat affecting their bonding strength and flexibility (creep). Epoxy, polyurethane, and urea formaldehyde glues cure by chemical reaction. They remain rigid and are not susceptible to heat and moisture and thus there is no creep.

Open time is the amount of time you must get you joint assembled. PVA glues are about one-half water. Once the glue is applied, the water begins to evaporate and soak into the wood fibers. Be aware that the stated open time is dependent on air temperature and humidity. Once you have exceeded the open time, the glue has skinned over and your chances of getting a good bond are slim. Given our location in the Central Valley during the summer period, you should assume open time is half the stated time.

Titebond II and III are FDA approved for indirect food safe contact. Titebond III is a better choice in term of withstanding higher temperatures, less creep and longer open time.

There are nine categories of adhesives that I will be discussing: PVA, polyurethane, hide glue, urea formaldehyde, epoxy, CA, contact cement, hot glue and glue sticks.

Polyvinyl acetate (PVA) glues:

The most common wood glue is probably Titebond original yellow or some form of white glue. These will handle 80-90-percent of the wood working projects in your shop. They bond most woods.

PVA glues work via evaporation and absorption of water into the surrounding wood fiber. When the moisture evaporates, the glue hardens and the two adjacent pieces of wood are bonded. That's why wood joints should be glued right after cutting, jointing, etc. If a week or more has passed since the wood was last worked, resurface.

What's the difference between white and yellow PVA glues? This is a very confusing topic and glue color means nothing. Dye is added to the glue to create the desired color. You must consider the merits of individual glue products.

The other important factor in glue strength is to have a very thin, continuous film of glue in the joint. Do you spread glue on one or both surfaces?

Simple (uncompounded) PVA – Elmer’s Glue All. Good for crafts, but not wood working.

White and yellow glue (compound PVA) – These are polyvinyl acetate adhesives or PVA glues. Elmer’s Wood Glue, Titebond I, II, and III are examples

Custom PVA Blends - Special-blend PVAs possess certain abilities that have made them shop favorites:

- ✓ Titebond Extend - is useful in complex glue-ups. With a 15-minute open time (twice as long as Original Titebond),
- ✓ Speed set - Titebond Speed Set Wood Glue is an extremely fast-setting, high solids PVA adhesive. It provides exceptional gap filling properties developing a bond stronger than the wood itself. Open time – 2-4 minutes, total assembly time 8-10 minutes, 15-minute clamp
- ✓ Titebond Melamine. As the name suggests, this PVA sticks to melamine, and vinyl, high pressure laminates (and wood).
- ✓ Quick and Thick or molding and trim – No-run, no-drip stays put and grabs quickly, making it perfect when installing molding and trim.

Unibond One – This PVA glue (brown) is especially useful in veneering and laminating wood. It was developed to produce an extra hard glue line (little or no creep), allow a longer open time, and block bleed through on veneer. Titebond Cold Press glue (white) has similar characteristics. Glue color could be a deciding factor here.

Polyurethane – Think Gorilla Glue. Polyurethane glue reacts to moisture. Dampen one contact surface with water before bonding. Polyurethane glue has an open time of about 20-minutes but produces a foamy squeeze out that can be tough to deal with. It can expand up to 3 times as it cures. You can remove the foam with denatured alcohol, but it may be better to wait and scrape off the cured residue. You may be able to remove the foam with a tooth brush and mineral spirits.

Since polyurethane glue is not water based, it won’t cause the wood to swell when applied. It is also very slippery, so tight fitting parts tend to slide together with ease.

The stuff seems to get everywhere. Glue can stain skin (wear gloves). Polyurethane glues are water proof and will adhere to most wood, metals, stone, ceramics, and many plastics. Use a very small amount of adhesive. Rather than “drying” like most PVA glues, it reacts chemically with moisture, expanding and filling voids to create a strong bond. As it expands, excess glue will

bubble out of the joint. While the expansion will fill gaps, it doesn't form structural strength like epoxy. When cured, these glues don't creep.

It's not water soluble, so you can't just wipe it off. Since it reacts to moisture, be sure to squeeze all the air out of the bottle once open.

Hide Glue

Traditional hide glue - Traditional hide glues are made from processed animal skins and bones. It has been used to assemble furniture for thousands of years. It comes in granular form that you must prepare by soaking in water. This mixture is then heated to about 140-degrees. Hide glue has been used for centuries and is tough and durable. Glued joints set-up almost immediately, but takes 24-hours to fully cure. Hide glue is reversible. Steam or a hot towel will cause the glue to release.

There are some downsides to using hide glue. Like food, used hide glue can go bad quickly. It can grow mold which reduces adhesive qualities. It has a certain aroma.

Liquid hide glue – Provides all the advantages of original hide glue in a ready-to-use formula. It is kept liquid by adding urea, salt, or other chemicals. Like traditional hide glue, it is reversible by application of moisture. Unlike many other adhesives, its dried film is only minimally resistant to penetrating stains. With liquid hide glue, you want to look for an expiration date on the bottle before you buy it. This is more critical than PVA glues.

Shelf life is 18-months to two years if kept sealed in a cool and dry location.

Liquid hide glue has a longer working time than most PVA glues. The open time is generally 10-minutes, with a total assembly time of 20-30-minutes. Liquid hide glue is much less likely to seize your joint during assembly. This probably due to the longer open time. Liquid hide glue is good alternative to PVA glue for complicated glue-ups.

One hour in the clamps is good overnight is even better. Like traditional hide glue, it is reversible.

Patrick Edwards makes a liquid hide glue called **Old Brown Glue**. Formulated his own version of hide glue.

Urea Formaldehyde -- Good for veneering and bent laminations. Contains formaldehyde. Wear gloves, eye protection and a respirator. Available in powder or liquid forms. Unibond 800 is an example of liquid version and Weldwood Plastic Resin Glue the powdered version. Very sensitive to temperature (must be above 70-degrees).

Urea formaldehyde glue has a long pot (4-hours) life and yields a rigid, high strength bond that resist water.

Epoxy – Epoxy is a two-part glue requiring mixing of two equal parts resin and hardener together to activate its adhesive properties. Epoxy glue is suitable for indoor or outdoor projects and bonds to almost anything, including metal. Hardening formulation can vary from 5-minute to a few hours. However, most epoxy requires 24-hours to achieve full strength. Epoxy does not

depend on clamping pressure to ensure adhesion, so light clamping pressure is best. Epoxy is waterproof. It can be used over a wide temperature range (-40 to +250 degrees Fahrenheit).

Like polyurethane glue, epoxy is not water based so parts won't swell and will sip together easily. Good for laminations, outdoor furniture, and gap filling. They are better in heat and chemical resistance than other common adhesives. Fumes and can be an issue. The best solvent for epoxy is acetone or lacquer thinner, but you need to clean it up before it cures.

CA (super) Glue – CA is short for Cyanoacrylate. It sticks the seconds when exposed to moisture. Write-up on SJFWA web site.

CA comes in a variety of viscosities: thin, medium, thick and gel. It is a fast bonding and tight holding glue which is appropriate for almost any project. Super glue will bond to metal, wood, plastic, clay, and many other materials. It is not susceptible to extreme cold or heat. It can be clear, black, brown or can be colored. There are flexible forms. It can stink to your skin (debonder) and is difficult to get off (deborder or sawdust) and is used medically as a bandage.

Most CA glues form a brittle joint and a sharp blow can break the joint. It is not a gap filler. It is mostly useful in the shop for making jigs, repairs and as a filler.

CA shelf life is about 1 year, depending on how it is stored. Store unopened bottle in the freezer or refrigerator. Opened bottles should be stored in a sealed jar with a desiccant in a cool location. You could place the sealed jar in the refrigerator to extend shelf life.

Spalted wood – wood starts to decay. Also, for you turners, use in areas with excessive tear out. Stabilize. CA glue excels in knot filling or stabilizing punky wood spots. It is also useful for hardening the edge of a template made from MDF.

CA glue comes in different purities. I like CA glue from Starbond. They make a wide variety of CA glues including black, brown and knot filling.

CA glue can stain the wood. This is especially true for soft woods. This can be prevented by applying a finish (lacquer or shellac) to the area before the glue. Also, don't overdo it on the accelerator. Too much accelerator can cause a white blush or hallow.

Do not use CA glue on foam, polyethylene and/or polypropylene plastics. Keep the tip of the spout from touching the work surface. Foreign matter is effectively telling the glue to cure or clog the tip.

Accelerator– Use small amount. The spray only affects the surface and doesn't go deep inside. Will harden without accelerator-takes a while. You can make your own accelerator. Just mix 1/2 teaspoon of baking soda into 1/4 cup of purified water. Brush it onto the “dry” half of the joint.

Spray adhesive – This is a fast-acting adhesive. Spray-on multipurpose adhesives are perfect for a variety of shop projects—from attaching sandpaper to glass for sharpening, to sticking sandpaper to fences and jigs—these aerosols are super-sticky, and simple to use. When choosing a spray adhesive, note its tack (how quickly it bonds), and whether the bond is permanent, semi-

permanent, or temporary. High tack means that the adhesive grips instantly, while low tack means it can be repositioned. Use for making sanding blocks or attaching pattern to wood.

Contact cement – use only to apply Formica to counter tops (water or petroleum based)

Hot glue – This is a type of adhesive commonly used in arts and crafts projects. It is made from a plastic polymer that is melted and then applied to a surface. There are different types of hot melt glue sticks made from different plastic polymers. Be sure you get one that will work with wood projects.

The hot glue dries quickly and forms a strong bond between the two surfaces. It will not stick to smooth surfaces. The glue sticks do have shelf life, usually 1-2 years depending on temperature. Hot glue is not designed for high strength applications but does have a place in the wood shop.

The benefits of hot glue are that it is easy to use and fast. They adhere a wide variety of materials including wood, paper, plastics, leather, etc. Hot glue has a low viscosity which results in good control. It dries quickly which holds objects in place without the need for clamps. It can withstand relatively high temperatures without dissolving or becoming brittle. Glue sticks are available for various applications and colors. You need to choose the glue stick based on intended application. Glue sticks come in various strengths. They are ranked based on strength (low to high). In general, hot glue can handle between 600 to 700 pounds of weight. Hot glue can be removed from surfaces using rubbing alcohol or a heat gun.

Gorilla and Surebond are two brands that would be appropriate for wood working.

Titebond HiPur - polyurethane hot melt adhesive. Like traditional hot melt, except after it solidifies PUR absorbs moisture. The intake of moisture creates a permanent chemical change after several days. This change increases both heat and chemical resistance.

Industrial hot glue is used in furniture some assembly to adhere small joints, mounting trim, etc. Hot glue sticks come in different grades, depending on anticipated use. It also comes in different colors and can be used for knot filling.

Cartridges are expensive (\$12) and have a shelf life of about 1-year. Once opened, they need to be used within one month. They could only be justified in a situation where clamping is an issue. Not very practical. However, trim carpenters seem to like this product

Glue sticks – Can be a useful temporary adhesive.

Conclusion – Experiment with various glues to see what works for you. Don't be afraid to do the torture test.

GLUE UP TECHNIQUES – TIPS AND TRICKS

Gluing oily woods – Because a surface layer of oil or tannic acid tends to build up on these species (teak, cedar, redwood and most "exotic wood" species). They can present a problem. Planning, jointing, or sanding just prior to gluing will remove the contaminating layer and allow successful bonding. Otherwise, the surface needs to be wiped with acetone to remove the oil or tannic acid.

Removing squeeze out – Pre-finish projects prior to assembly. This could be as easy as applying a wash coat of shellac or the actual finish. Tape joints that you plan on gluing. Use painters' tape on seams to catch glue squeeze-out.

Finishing prior to glue-up - Glue joint "squeeze out" may make the area around the joint difficult to stain. Use masking tape to cover the areas that you do not want glue to soak into. The sections that were masked will be free of stain-resisting glue when the masking tape is removed.

Sizing – End grain joints can be difficult to glue because the end grain sucks up the glue, which can result in a glue starved joint. The solution is to spread a thin coat of glue first, letting the end grain fibers soak up the glue and thus sealing the fibers. There's no need to thin the glue with water, just be sure to apply a thin coat of glue. Wait a minute or so and then go ahead and glue-up the joint. An alternative is to thin the glue, about 10 parts water to one part glue.

Disassemble a glued joint – The key is to weaken the bond. For original, Titebond II and III, raising the glue joint temperature with a heat gun will reduce the glue strength. Steam from an iron may help. For liquid hide glue, placing a few drops of water on the edge of the joint will cause the joint to weaken.

Wood species consideration - When different wood species are used in a project, it is important that all woods have the same moisture content. Storing all the wood together in the same warm, dry location before beginning the project will help all the wood reach the same moisture content.

Wood filler - Use a small artist's brush to coat the surface with glue before applying homemade wood filler. Doing this will assure that the surface is wet enough to encourage adhesion. Otherwise, the wood filler mix may be too dry to adhere well to the surface to which it is being applied.

Stepped joints - Stepped joints typically result when pieces of wood of different moisture contents are edge glued together in making a tabletop or cabinet door. It is important to be sure that all the wood for a given project is at the same moisture content before beginning a project. Allowing the wood to acclimate or sit exposed in your shop for a week or two is one way to be sure each piece of wood has a similar moisture content.

Can high moisture wood be glued? - Moisture levels above 10% can slow the drying of water-based wood glues such as Titebond Original, II and III to the point where, wood above 16% moisture content, may not dry at all. Water based glues can take 24 hours to fully cure before machining.

Dealing with squeeze out - You want to see some glue squeeze out after a joint is clamped. But how do you prevent the glue from getting onto the adjacent wood and interfering with your finish? One approach is to apply finish to the project prior to assembly. This could be a wash coat of shellac or your final finish. Glue will not stick to the prefinished surface. Be sure to tape the area that will receive glue so that finish doesn't get on them.

You can apply painters' tape to adjacent joints so that glue squeeze out get on the tape and not the wood.

Allow the glue to set-up and then it can be removed with a chisel or putty knife. A straw with the tip cut at a 45-degree angle makes a handy device for collecting glue squeeze out.