

The cyanoacrylate glue, popularly referred to as superglue is one of those additions to the workbench which brought a small technological revolution in modelling. Not only did it allow to bond different materials such as metal to plastic, but also opened up the way for entirely new modelling materials such as resin. Used on plastic, it provides non-shrinking, non-destructive seams that are just great for sanding. Applied as filler, it takes scribing unlike any other.

Since there seems to be a degree of confusion about how cyanoacrylate glue works and what it is best used for, I have made some research, the results of which are presented here. The information contained below comes from interviews I made at the Department of Fibre and Polymer Technology at the Royal Institute of Technology in Stockholm and from a variety of sources on the Internet.

What is Superglue?

The correct chemical designation for the CA glue is ethyl 2-cyanoacrylate. An acronym ECA is also used in chemistry. There are also numerous trade names, including superglue (of course), permabond, pro grip, black max, crazy glue, cyanolite, superbonder and so on.

The actual composition of most commercial glues is typically ca. 91% ethyl 2-cyanoacrylate, 9% polymethylmethacrylate, <0.5% hydroquinone and a trace of organic sulfonic acid. Thin-running Crazy Glue and Super Glue are believed to be essentially 100% ECA.

A common source of confusion is mixing up CA glue with Loctite thread locking glue. The main reason for this seems to be historical. The Loctite brand that initially produced the thread locking glue became for many users synonymous with that type of glue. Nowadays, Loctite has an entire variety of glue products in its range, CA glue among them. The main difference between the two types is in the medium activating the bonding reaction. In the thread locking glue, polymerisation starts in the absence of oxygen (air), while CA bonds with the aid of humidity.

How it Works

The cyanoacrylate glue hardens very quickly when trapped between two surfaces. The reaction is caused by the condensed water vapour on the surfaces (namely the hydroxyl ions in water). The water comes from the surrounding air, so obviously the air humidity is a factor that may affect bonding capabilities, or cause them to differ from application to application.

The curing reaction starts at the surface of the bonded material and develops towards the centre of the bond. Because of this, thick seams or large blobs of glue may harden less satisfactorily than surface-to-surface bonds with good fit. In a thick blob of glue, a polymerisation reaction may stop before it reaches the

centre of the blob. A rule of thumb is that seams thicker than 0,25 mm should be avoided. Thick seams will also take longer time to cure.

The described relation between seam width and curing time can be used to advantage: a thick superglue-filled seam will allow adjustment of the parts, but will bond instantly and definitely when they are pressed together, so that the gap decreases below 0,25 mm. Pressing the parts harder against each other will make the glue cure instantly.

CA applications

The best use for CA glues is undoubtedly attaching small details, where small amount of glue would cater for thorough polymerisation and advantage can be taken of the extremely fast bonding time.

CA glue will provide strong bonds on a wide variety of materials. The shearing and pulling resistance are very good. However, it should not be used on glass or on parts that are exposed to water.

Curing time and slow-setting inhibitors

The hardening reaction can be described like this. The cyanoacrylate is a polymer which contains its own hardener compound. However, a weak acid is added acting as an inhibitor, preventing the reaction and "holding apart" the molecules which accounts for the liquid consistency of the compound. When exposed to water, the acid is dissolved. It triggers a chain reaction and the compound cures to the solid state.

Manufacturers use the inhibitor to control the curing time of the glue. Slow-setting superglues have a larger proportion of inhibiting acid in the basic mixture.

Accelerators

Besides water, cyanoacrylate polymerises also in presence of alcohol and basic compounds (including weak amines). The latter can be used to produce a superglue "kicker" – a compound which triggers quick polymerisation of the glue.

Baking soda is one well-known substance with this effect. If you apply a layer of superglue to a seam and gently pour baking soda over it, the glue will cure very quickly. It makes for most effective filler for smaller jobs, and the baking soda results in a slightly rough surface which is good for sanding.

The great advantage of using superglue as filler is the total absence of shrinking which plagues most solvent-based fillers on the market.

There are also commercially available liquid accelerators, but as baking soda has the same effect, I personally prefer it over another harmful chemical in my workshop.

Like water, the accelerator also affects the reaction through surface contact, so it will be much less effective on thick layers of glue. When filling larger recesses

with superglue, it is therefore advisable to build up the volume in several thin layers rather than applying a large volume of glue at once.

With these precautions (i.e. working with small amounts at a time), CA can also be used for moulding smaller detail parts, which I have tried with success.

A word of health warning

Be mindful that superglue comes with its own set of health hazards.

The glue has a distinctive, strong, acid odour. Breathing cyanoacrylate fumes is irritating for your breathing organs. For some individuals, repeated or extended exposure to fumes may prompt chronic allergic reaction. In dry air (less than 50% humidity), fumes may be also be irritating to eyes, stimulating tears.

In contact with the skin, the primary risk with the CA is bonding fingers or other body parts together. This goes also for eyelids, no remember to never ever poke your hands into the eyes while working with superglue!

In skin or eye contact, CA is deemed to be non-toxic, so don't panic, assess the situation, and seek medical help if necessary. Never try to tear the apart the bonded body parts!

It is also ascertained that CA cannot trigger allergic reactions through skin contact.

The wisdom of the above is that safety glasses and breathing masks are best worn when working with these glues. A good ventilation is also a must.

Cyanoacrylate or **CA** glue has changed the way models are built more than any other advance in modeling technology. In the good ol' days, model cement like Ambroid, Duco, Comet, and Sigmoid were the glues of choice. They all had a strong, unpleasant odor, dried slowly (compared to CA) and became brittle with age. CA, on the other hand, is stronger, works almost instantly, and is bottled in three different viscosities (thicknesses). CA is used for most glue joints, except where epoxy is specified. CA does emit rather strong fumes (some say it's like tear gas) as it cures, so rule number one is to work in a well ventilated area.

In some cases, the instant CA will puddle in a small gap. You can make it cure by dusting it with baking soda. You can even fill small gaps with instant CA by putting some baking soda in the gap and then dripping the glue into it. Don't try to make large fillets, however, because the glue will not penetrate too deeply into the powder, and you'll have a thin shell of solidified glue over a core of baking soda powder. This isn't strong.

CA adhesives are non-toxic, but can release fumes that are irritating to the tissues in the nasal passages and eyes. Some people have strong reactions to this, getting asthma-like symptoms. The fact that the CA glues can harden very quickly in the presence of moisture can cause burns if the glue gets in the mouth

or eyes. It's virtually impossible to swallow the glue because it will cure as soon as it gets into the mouth. Because human skin always has some residual moisture on it, CA adhesives will bond skin instantly.

Pro Thin CA is also known as plain CA. This is the instant variety, used for most initial assembly and tack gluing. Thin CA is water-thin instant glue, requires a joint with no gap and will cure within seconds of application. Thin CA is usually "wicked" into the joint by putting a few drops on the seam, then holding the parts together while the CA penetrates and bonds the parts. When gluing plywood or hardwood, a mist of accelerator (see below) will help the CA work.

Pro CA+ is also known as medium or gap filling CA. CA+ is used for surface gluing, filling small gaps between poorly matched parts, and for general purpose applications. It cures slower than thin CA, allowing you to apply a bead to two or three parts before assembly. Also, because it cures slower than thin CA, it penetrates the wood for a stronger bond. Curing time without accelerator is 20 - 30 seconds.

Pro CA- or thick CA is used when extra positioning time is needed. CA- is a great gap filler and is also used to make fillets when a little extra strength is required. Curing time is about 1 - 2 minutes.

Finally, **Pro CA Gel** is the version that has the consistency of hair gel, and has the longest cure time. It's useful where you have to apply the glue and then fit the pieces together.

Accelerator (or activator) is a liquid chemical that comes in a spray bottle or aerosol can for use in speeding up the cure time of all CA types. It should be misted on, not sprayed heavily on the joint. The glue will instantly harden. Accelerator may cause exposed CA to bubble and sometimes change color. A drawback to accelerator is that the CA cures before it has time to fully penetrate the wood, so it should only be used sparingly—when absolutely necessary.

Note: Don't use accelerator on instant CA. It will cure so rapidly that gasses will form in the glue and it will become a hard foam with very little strength.

A word about CA safety - After applying CA, don't stand directly over the work. Avoid the puff of vapors. All CA glues will bond skin almost immediately. If this should happen, **CA Debonder** (available from your hobby dealer) or acetone fingernail polish remover will dissolve the CA if allowed to soak into the bond for a few minutes. Don't use vigorous means to separate a skin bond. In case of eye contact, flush thoroughly with water, then seek medical attention, but don't panic. Please, keep CA (and all other modeling chemicals) out of the reach of children!

Epoxy glues are among the strongest glues used in model building. They will bond a large variety of materials together. They are also very good for laminating

wood sheets because they will not cause the wood to curl.

With any glue, you have to make sure you have a coat of glue on both surfaces to be joined. If the coat is too thin, it will be "sucked" into the wood and there will be no glue left between the pieces to bond them together. You must get some "squeeze out" of the glue when you join the pieces together. This insures a good bond.

With epoxies, the longer the cure time, the stronger the joint. This is because longer cure times allow the glue to get good penetration into the pieces being joined. It also allows the molecules in the glue to align better, which gives the joint its strength.

Epoxies can cause skin allergies, so any amount that gets onto the skin should be immediately cleaned off. Use rubbing alcohol for cleanup, followed by a thorough wash with soap and water. It's best to wear latex gloves when using epoxy to avoid getting it on the hands. Skin reaction is cumulative, so you may be able to get away with skin contact of the glue at one time, and then have a reaction at a later time.

Great Planes has two Epoxy formulations available for the modeler. Use them when the joint requires exceptional strength, such as when installing the firewall, when joining the wing panels, and when installing wing hold-down blocks. As with most epoxies, you mix equal parts of resin and hardener, stir well, then apply a thin film to each part. Parts should be clamped, pinned, taped or weighted in place until fully cured. Before the epoxy cures, clean off any excess with a paper towel. A word of caution about mixing epoxy—don't use extra hardener in the hopes of making the mixture harder or work faster. Just about all epoxies work best with exactly a 50/50 mix. When you increase the amount of hardener you run the risk of causing the cured epoxy to become either brittle or rubbery—neither being as strong as a properly mixed batch.

6-Minute epoxy is used for simple, small gluing operations where elaborate alignment is not required. Working time (before it's too goeey to use) is about 5 minutes, handling time 15 minutes, and it's fully cured in about 1 hour.

30-minute epoxy is used for extra strength (because it can penetrate longer) and where several parts must be aligned and checked before it cures. Working time is about 25 minutes, handling time 2 hours, and it's fully cured in 8 hours.

Epoxy Finishing Resin is designed so that it will form a nice, smooth film on the top of wood or cloth. Finishing resins do not have strong molecular links in the cured material, so they are not good at all for using as a general-purpose adhesive. Don't use finishing resin for laminating wood. Finishing resin is good for bonding fiberglass cloth to the model's surface to add strength and make a good surface for paint. Finishing resin is also used inside fuel tank compartments as a

fuel-proof coating.

Finishing Resin is mixed 1:1. It's applied with a brush, working it through the cloths's surface. After application, squeegee off any excess resin with an old credit card or stiff cardboard. Allow it to cure overnight. The resin can then be wet sanded and re-coated if needed.

CA Glues

In this age of instant gratification, we have universally accepted Cyanoacrylate (CA) glue for one single characteristic - *Instant Cure*. We willingly overlook its many failings for this one convenience. CA glue is not a good structural adhesive for wood and it is not a good "crack filler". Yet, these are the most common uses for CA glues by the woodturner. Our best use for CA may be as a wood hardener and a finish.

As a structural glue

CA glue is fast and easy to use, but there are many problems:

- CA cures to a brittle material that is easily fractured and shattered.
- Because it is brittle, the glue-line can easily fracture from shock, fatigue, vibration, and wood shrinkage or movement.
- Its "full strength" is developed only in a 100% contact joint. There is a considerable sacrifice in the strength in any joint that has anything less than "full contact".
- We use the "Thick" CA for its "gap filling" ability when our joints are not as good a fit as we would like them to be, but its brittle nature will allow the greater thickness of the glue line to fail faster.
- CA is difficult to use with dry wood because it requires some moisture in the wood for it to cure, but...
- CA glue loses its bond with the wood very rapidly in the presence of excess moisture.
- The "thin" varieties can penetrate so rapidly into the wood that there is nothing left in the joint to create a bond.

Most of the time we can get away with using CA glues because we are staying below the limits of its strength and durability, and any elasticity in the joint is from the wood itself, not the glue. When these limits are exceeded, the bond will fail, and these failures are what will get us into trouble.

Our biggest concern for using CA as a structural adhesive would be when holding a waste-block to a piece of wood. We always risk a failure of the brittle glue-line from fatigue caused by the cyclic stress reversals of the rotating weight or from vibration in the joint. Small pieces may not present a problem, but we should be using a stronger more durable adhesive such as Titebond or

Polyurethane for heavy and/or unbalanced pieces of wood.

If we insist on using CA for attaching a waste-block, the strongest CA joints that I have seen use both the "Thin" and "Thick" types at the same time. The adjoining surfaces are made as close to flat as we can get them by using the lathe, a hand-plane, or other means. "Thick" CA is spread on one surface, and a similar coat of "Thin" CA is spread on the other. The waste-block is then quickly put together with the wood and moved around to mix the two adhesives and spread it into a thin layer. It is then clamped or weighted in place and allowed sit for about 10-minutes before mounting the piece in the lathe. It isn't "instant" but it is a stronger and safer joint than one that is. I use this method for attaching a disc of ¼" plywood to the bottom of plates and small platters for use as a chucking spigot.

As a "crack filler"

CA is fast, and easy to use, but it may not be the best thing to use for filling voids and cracks in a piece of wood.

- We are all familiar with the most common problem - the CA penetrates into the wood and leaves a large hardened stained area around wherever it is used. And, there is no way to remove or cover this stain, other than turning or sanding down through it.
- A large piece of CA filler is like a "rock" stuck in the wood. It does not move with the wood. Over time, any wood movement or shrinkage will either cause the CA glue to crack and separate from the wood, or fracture the wood at the bond with the filler. I have seen them fall out.

And, if that isn't enough,

- It will not easily bond to oily or resinous wood.
- It shrinks as it ages.
- Some CA glues will turn a nasty looking dark orange color as it ages.

A better alternative is an epoxy or Titebond glue with colorants and/or wood dust added to fill the cracks and voids.

An alternative for filling smaller voids is one of the commercial wood fillers, such as "Famowood" or "Wood Patch". These products dry to a hardness that is somewhat softer than the surrounding wood, are easily sanded, and they are compatible with almost any finishing product that we want to use.

CA with Inlace and other decorative materials

We are using more materials such as "Inlace", brass powders and filings, stone, etc. as a decorative addition to our woodturnings, and CA glue is usually the recommended adhesive. But, for all of the reasons that I have listed, CA may not be the best adhesive for holding these materials in place. CA glue is fast, easy to use, and it will look good now, but come back in 5-years after it has started to discolor, shrink, or separate from the wood, and tell me that using it was the right

thing to do. An epoxy resin is a far more durable adhesive for this purpose, but it isn't as fast.

CA as a finish

CA glue leaves a hard durable surface film, that would seem to make it a good finish. The reality is that it has no advantage over the other finishes that we can use, and there are several problems with its application and use.

- CA is a very expensive finishing material when compared to the other products that we can use.
- It is difficult to apply because of its fast drying. Unless we are able to give the entire piece a single wet coat, there will be discoloration problems with heavy and light areas and overlap lines where the wet edge has cured.
- Discoloration from the staining and differences in grain penetration can cause a worse "blotching" of the wood surface than an oil finish.
- CA glue is the most brittle finish that we can put on a piece of wood, and as such, it can develop hair-line cracks and/or separate from the surface as the wood adjusts to its final shape after turning or moves with seasonal changes.
- The cured CA glue is a plastic material, it must be sanded and polished as such, it wears like plastic, and it looks more like plastic than anything else we can apply to a piece of wood, including Polyurethane (my opinion).

As a finish, CA should be applied with one uniform wet coat on the entire piece. This is best done with a slow curing CA, but there will still be a limit on how large an area can be covered in the short time that is available. The use of CA as a finish or a wood filler is described in my Finishing Secrets, "Chapter 4 - Pens, Watches, and Small Personal Items". These same techniques that are described can be expanded to larger items.

A different technique for using CA as a wood finish is described in an article by Bill Haskell, "An Amazing Finish", American Woodturner, Winter 2002 issue, page 47.

CA as a wood hardener and stabilizer

If we can live with its staining and other faults, CA glue is an effective "hardener" for soft and spalted woods, and it can be used as a grain-filler for open grained woods when it is mixed with fine wood-dust. In either case it should be sanded after application so that all of the remaining CA is "In" the wood rather than "On" it. This application is described in more detail in my earlier article, ["Finishing Secrets: Chapter 4 - Pens, Watches, and Small Personal Items."](#)

Accelerators for CA glue

There are two (2) problems that can result from using an accelerator, whether it is one of the commercial products, water, or whatever else may be used.

- The accelerator will enhance the brittleness of the cured glue.
- When applied too quickly to a thick film of CA, the glue will foam up into a white substance that has the appearance of a hard styrofoam, and has about the same strength.
- The accelerator can seal a pocket of uncured liquid under a thick application.

These problems can be reduced by always applying the glue in thin layers, waiting 1-minute before subjecting any CA glue to an accelerator, and eliminated altogether by not using one at all.

Parting thoughts on CA glue

Not all CA glues are created equal. Some can be more suitable than others for use as a wood glue, and how suitable seems to be directly proportional to its price. The first commercial CA was "Crazy Glue" in the consumer market, and "Hot Stuff" in the hobby market in the mid-60's. These two products are still with us, and have been joined by other name-brands, and a host of generic products.

Although I have used nearly every brand that has been available since the first "Hot Stuff", I have always had better results with the "Zap" brand than any other. "Better results" is a subjective definition that comes from years of using a product and becoming familiar with it. "Zap" is made by Pacer Technologies, and it isn't available from any of our normal woodworking/woodturning suppliers. I purchase it from Tower Hobbies at www.towerhobbies.com

In case anyone is wondering, yes, I do use CA glues, but I also recognize their limitations, and don't try using them at the exclusion of all other adhesives. I use them for such things as hardening wood under the chuck jaws, to hold temporary alignment blocks for gluing segmented assemblies, attaching waste-blocks where it is appropriate, stiffening and permanently attaching the bark on a natural edge bowl, as a wood-filler and hardener for pen barrels, and similar tasks for which it is well suited. And, I use CA glue to fill small cracks because it is fast.

Storing Cyanoacrylates

Most CA's have an average shelf life of about 6-12 months once opened. Unopened bottles can be stored in the freezer for an extended period of time. However, once a CA bottle is opened and exposed to atmospheric moisture, different storage procedures are required to prevent premature curing in the bottle.

- **Unopened Containers:** Unopened bottles should be stored in the freezer for the longest shelf life. Before using, allow the bottle to come to room temperature. I prefer to allow the frozen bottle to sit overnight on the bench before using it, to insure that it has reached uniform ambient temperature.
- **Opened Containers:** Do not store opened bottles without their caps,

unless you live in areas that routinely have **very low** humidity levels year round. Exposure to high humidity can cause premature curing of the CA in the bottle.

If you purchase your CA in bulk containers and transfer them into smaller applicator bottles for use, ensure that these bottles are manufactured from polyethylene for best storage results.

Do not store opened CA containers near your manual pump accelerator bottle. During the summer months, high heat can cause accelerator vapors to leave the pump spray unit, causing premature curing of a nearby CA bottle. Some accelerators are now available in pressurized spray cans. While these are more expensive initially than bulk liquids, over time I have found out that they end up costing less per use than the bulk liquids.

Do not store opened bottles in the freezer. When removed, condensation may develop inside the bottle causing premature curing. For best long term storage results, store opened CA bottles in a jar with a desiccant to absorb any moisture inside the jar. When stored this way, you can usually get every drop out of the bottle. Another option is to place the opened CA bottles inside a jar with a mason lid and pull a vacuum on the jar. This works very well, but requires a vacuum unit.

If you do not have one, use the above method with desiccant packs to remove any moisture inside the jar. Desiccant packs can be purchased at most camera and electronics stores, or be scavenged from the boxes of any new electronics that you purchase.