Cyanoacrylate glue – for Wood Workers

©Trevor Pope (tpope AT iafrica.com) – Nov 2007

Cyanoacrylate is the generic name for superglue. Cyanoacrylate glues are sometimes known as "instant glues" or by the name Super Glue. The acronym "CA" is quite commonly used for industrial grades.

Monofunctional cyanoacrylates were first discovered in 1942, by Harry Coover at Eastman Kodak when searching for a way to make plastic gun-sight lenses. It did not solve this problem, since it stuck to all the apparatus used to handle it, including the expensive lenses in the refractometer. Cyanoacrylates were not patented until 1949. In 1951, scientists at Eastman Kodak accidentally discovered the rapid ambient-temperature cure and superior adhesion properties of CA. The first viable production process did not evolve until 1954. It was patented in 1956 and developed into *Eastman 910* adhesive in 1958.

Chemistry

In its liquid form, CA consists of monomers of cyanoacrylate molecules. Methyl-2-cyanoacrylate (CH_2=C(CN)$COOCH_3$ or $C_5H_5NO_2$) has a molecular weight equal to 111.1, a flashpoint of 79 °C, and 1.1 times the density of water. Ethyl-2-cyanoacrylate ($C_6H_7NO_2$) has a molecular weight equal to 125 and a flashpoint of 75 °C. These are short chain polar molecules. Polar means that they have charged ends, and by making the liquid weakly acid, they are kept apart. Anything that disrupts this polarization will allow the molecules to link together, polymerizing, to form long chains called polymers. Polymerization can be trigged by a change in pH by the addition of a base, or even dilution with water. Once triggered, polymerization proceeds rapidly and the glue sets, joining the surfaces together.

Because the presence of moisture causes the glue to set, exposure to moisture in the air can cause a tube or bottle of CA glue to become unusable over time. When the bottle is not in use, replace the cap, to exclude any moisture that may cause setting. Alternatively, to prevent an opened container of glue from setting before use, it must be stored in an airtight jar or bottle with a package of silica gel to absorb moisture. Storing CA glue in the fridge reduces the reactivity and retards setting. However, before using CA taken from the fridge, give it time to return to room temperature.

In the right conditions CA glue sets quickly, often in less than a minute. A normal bond reaches full strength in two hours and is waterproof. Accelerators can trigger setting in two or three seconds, with some loss of strength. Over-use of accelerators can cause a white haze to appear on the surface.

Acetone, which is sometimes found in nail polish remover, is a commonly available solvent capable of softening cured cyanoacrylate. Nitromethane is also an excellent solvent. Methylene chloride found in some paint strippers is the most effective but is toxic.

Pure CA is very thin, such as sold by Qualichem as the product Magic Wood. For other applications, additives can be used to thicken the glue to provide better gap filling properties. Other additives can improve flexibility, shock resistance, UV resistance, etc.

Uses – accelerators, gluing, filling

Cyanoacrylate is a strong glue, particularly when used to bond non-porous substrates or those that contain minute traces of water. It is also very good at bonding body tissue, and while this can be a bothersome (or even dangerous) side effect during everyday use, some varieties are used in medical applications.

Curing (polymerization) is triggered at the interface of the glue to the material or substrate and then proceeds into the glue, as long as the conditions are right. In a thick layer, the conditions in the centre may not be suitable, where it may remain uncured. This means that thin glue sections are best – less than a ¼ mm.

Turners like CA glue because it sets quickly and then can be cut or sanded. Very few large pieces of wood are crack free, so CA glue allows wood that a cabinet maker would put on the fire to be turned. Fill the cracks with wood dust and then apply thin CA glue such as Magic Wood. Narrow cracks can be reinforced and soft wood strengthened to improve the mechanical integrity of a piece. Spigots for gripping in a chuck can be reinforced with a layer of CA glue.

Bear in mind the type of finish on the wood, as CA glue can spoil the appearance of some woods, but not be noticeable on others. It is best to apply it to cracks while turning down to size, so that any surface staining is removed. It obviously penetrates more into end grain and that is where cracks are more likely to be found, so bear this in mind when refining the final shape of the piece. You may want to experiment with glue and the finish you plan to use to see if it likely to spoil the appearance.

If applied to cotton, cyanoacrylate undergoes an exothermic reaction rapid enough to cause minor burns if spilled on clothing, although this reaction is not powerful enough to be noticeable unless it involves more cyanoacrylate than any non-commercial use would reasonably call for. You will notice a similar reaction with wood dust or shavings that are also essentially cellulose. The large surface area and residual moisture promote rapid polymerization and emission of heat.

CA glue has a low shearing strength, which has also led to its use as a temporary adhesive in cases where the piece can easily be sheared off at a later time. Common examples include mounting a work piece to a sacrificial glue block on a lathe and also tightening pins and bolts.

One non-adhesive use for CA is as a forensic tool. Fumes from warmed CA can develop latent fingerprints on surfaces. The invisible fingerprint residues react with the CA fumes and atmospheric moisture to become visible and can then be recorded. This technique was shown in the films *Beverly Hills Cop II*, *National Treasure*, and frequently features in the television series *CSI: Crime Scene Investigation* and its spin-offs.

CA glue doesn't bond well when it is cold, ie below 10 °C. At room temperatures, to speed up bond and improve gap filling, an accelerator can be used. These are usually in the form of a liquid that is sprayed onto the glue or one surface before the two are put together. Even water can serve as an accelerator. Remembering that a change in pH can cause polymerization to start, a simple solution of bicarbonate of soda in water can work as an accelerator. Other accelerators may contain isopropanol, heptane, acetone, perfluorocarbon or propylene based glycol ether. Most of these are polar solvents, which seem to disrupt the polar arrangement of the monomers, triggering polymerization. There are a variety of formulations and applications of CA, so different combinations may work better than others.

Low temperatures cause CA to become brittle. CA bonds can be weakened (allowing disassembly) by placing a glued object in a household freezer for several hours.

CA has its limitations. It is not as strong as epoxy – it can be brittle and doesn't work well with oily woods. Its main virtue is its quick setting time, improving productivity.

Thin CA glue can be used as a wood finish. Its fast drying time and glossy finish make it ideal for small applications which generally look best when glossy (such as pens), although it is messy and somewhat expensive. Don't use an accelerator, which can cloud and thus ruin the finish. One formula used by flute makers is three drops of CA glue to a table spoon of oil applied to the outside. The inside is finished with non-drying oil.

Clogged nozzles from glue bottle tops can be recovered by soaking in acetone for reuse, so don't throw away your old nozzles. When one blocks up, swap it with another and soak it in a jar of acetone.

CA glue is not really suitable for general cabinet making. It is rather expensive and also brittle, not able to deal with small amounts of wood movement that PVA (white) glues can. Even a slow setting variety such as the one on the right takes 30 – 60 seconds – imagine trying to assemble a few joints in that time? Glue-up is nerve racking enough with normal glues where you have a few minutes to adjust everything square.

Safety – skin contact, eyes, fumes

CA glues bond skin and eyes in seconds. Studies have shown that methyl-2-cyanoacrylate (SuperGlue and KrazyGlue) degrade fairly rapidly upon contact with living tissue. This leads to the release of formaldehyde and a toxic response, killing tissue. 2-octyl cyanoacrylate degrades much more slowly due to its longer organic backbone which slows the degradation of the adhesive enough to remain below the threshold of tissue toxicity. Due to these toxicity issues, 2-octyl-cyanoacrylate is used for sutures.

Cyanoacrylates give off vapor which is irritating to eyes, mucous membranse and the respiratory system. ACGIH assign a Threshold Limit Value exposure limit of 0.2 parts per million. On rare occasions inhalation may cause asthma. There are a wide variety of adhesives of which different cyanoacrylate formulations may be a component. It is wisest to obtain and consult a manufacturer's material safety data sheet for a product in order to consider the specific hazards associated with exposure.

Although the fumes given off by rapidly setting glue are unpleasant and can trigger short-term reactions including asthma, they don't appear to have any lasting effects. This excerpt from a material safety data sheet states this:

> **A Material Safety Data Sheet listing for SuperGlue**:
>
> Health Hazard Acute and Chronic:
> Acute: IRRITATES EYES, MUCOUS MEMBRANES.
> Chronic: NO RESIDUAL AFFECTS OF ACUTE PROPERTIES.
> Carcinogenicity - NTP: NO
> Carcinogenicity - IARC: NO
> Carcinogenicity - OSHA: NO
> Explanation Carcinogenicity: NOT RELEVANT.
> Signs/Symptoms Of Overexposure: SEE HEALTH HAZARDS.
> Med Condition Aggravated By Exposure: PRE-EXISTING SKIN, EYE AND RESPIRATORY DISORDERS MAY BE AGGRAVATED BY EXPOSURE.

I haven't been able to establish exactly what the fumes consist of. It has been suggested that cyanide is a possibility, given the chemical composition of CA, however this can be discounted as the distinctive smell of cyanide (burnt almonds) is absent.

CA will set at different rates, depending on the conditions and formulation. When using CA glue on the lathe, it is important to remember that not all the glue may set instantly, and when starting up again, some CA may be flung off the work-piece, and it can get into your eyes.

You should always wear eye protection anyway when turning. My safety glasses have a few spots of CA on them as a warning. Always use eye protection with CA, as a drop in the eye will bond it closed almost instantly. Fortunately, this is not permanent, as apparently within two to three days, the glue will release from skin and the cornea, due to the surface chemistry. No attempt should be made to force open the eye, as this could cause damage – rather let nature take its course.

As we will all have discovered by now, skin is bonded almost instantly by CA glue. Don't attempt to pull away, lest you cause damage. A number of solvents such as acetone contained in nail polish remover will remove the glue. Apparently some oils such as citrus oils will also debond CA, albeit more slowly, but may be more acceptable than acetone. Proprietary de-bonders such as the one on the left are available.

Sources:

- www.wikipedia.org,
- Steven D. Russell on rec.crafts.woodturning and on his own web site at www.woodturningvideosplus.com/cyanoacrylates.html
- www.woodcentral.com,
- http://ipmsstockholm.org/magazine/2004/10/stuff_eng_tech_ca_glue.htm