

The Strength Inside your Model

Part 3

- Adhesives

John Bristow of Deluxe Materials '40 years and Getting Stronger focuses on cyanoacrylate glues.

Cyanoacrylate adhesives – the Super in Glue!

Since its introduction into the modelling market, cyanoacrylate (often referred to as ca, cyano or super glue) has become one of the most useful adhesives for the modeller, because it sets so quickly and bonds many materials.

The History

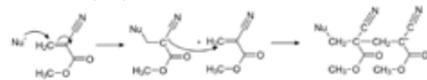
The original cyanoacrylates (the chemical name for the glue) were discovered in 1942 in a search for materials to make clear plastic gun sights during World War II. A team of scientists stumbled upon a formulation of a product that stuck to everything with which it came into contact. This material was rejected for the application in question! Then in 1951 Eastman Kodak researchers, Harry Coover Jr. and Fred Joyner recognized the true commercial potential, and rediscovered cyanoacrylates and 'Eastman 910' was born. The first cyanoacrylate adhesive were sold, in 1958.

Today, there are many big chemical manufacturers and marketers in USA, Europe and the Far East.

How and Why Cyanoacrylate Glue Works so Well

Cyanoacrylate glue cures by a catalytic process of rapid polymerization caused by moisture (or more specifically -OH groups) found in surface contaminants on wood, glass, metal, etc. that is to be bonded.

The equation for the setting (polymerisation) of a methyl cyano is set out below.



In total only around 5 or 6 cyanoacrylate monomers are commercially available and they are outlined in the structure above. The most common type of cyanoacrylate is the ethyl-2-cyanoacrylate type that is found in most products available in the market.

However, for more specialist applications others cyanoacrylate monomers have been developed. The major difference between each type is in the ester group (e.g. methyl, ethyl) - the larger



the size of the ester group, the slower the cure speed and the lower the bond strength. The higher analogues have found special use in the medical industry as tissue adhesives.

Creating a Strong Bond

Mechanical 'hooking' described in an earlier part of this series is one of the main ways in which this adhesives works and Cyanoacrylates bond especially well because they have one of the lowest surface energies of any adhesive on the market i.e. they 'wet' (attach to) most surfaces extremely well. Cyano bonds well to rubbers, metal, leather, balsa and hardwood and some plastics. Trace amounts of water present at the surface of the material to be bonded trigger the catalytic setting process. Acidic surface such as certain hardwoods or low surface energy plastics (Polypropylene) are more difficult to bond and require special grades or primers (Tricky Stick being one). The surface primers work by changing the cyano to improve wetting. Chemical treatments are also possible but not really practical for modellers.

Cyanoacrylate monomers are all very low in viscosity so ranges have been developed which include inert fillers to increase the viscosity to expand the scope of joints that can be bonded.

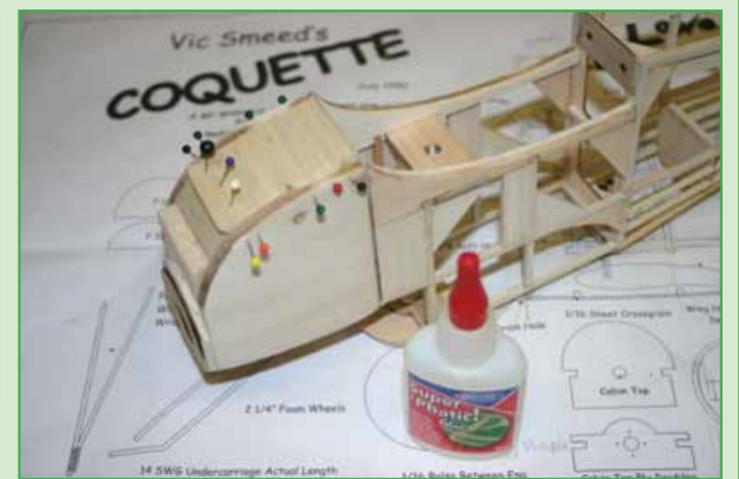
It is their unique chemical structure that allows cyanoacrylates to bond in seconds and makes them excellent adhesives for modelling. However they are not always the right glue for every job.

Limitations: Cyanoacrylates are very brittle and are not advisable where impact resistance is required. Rubber toughened cyanoacrylates have been developed to improve this limitation. Similarly you should not use them when bonding materials with significantly different thermal expansion coefficients such as glass to metal. This is likely to cause catastrophic failure; an example of this would be the bonding of a metal rear view mirror to a windscreen. Applications where there is constant exposure to moisture should also be avoided, as water will eventually break down the joint.

Shelf life: All cyanoacrylates have a shelf life



The Kingsport Times News remembers Harry Coover's rediscovery of cyanoacrylate adhesive when at Eastman.



Cyano isn't necessarily the right glue for every job, and the new thin aliphatics can be a sensible alternative or adjunct.

and this is really dependant on the storage conditions however most companies provide 12 month shelf life but this is dependent on the type and grade.

Bond strength and cure speed

Cyanoacrylate glue should be allowed to polymerize slowly and the bond should be left to develop for at least 24 hours. Heating the bond will increase the final bond strength. This is contra to the general understanding by modellers - fast is not strong. The slower the cure speed, the higher the bond strength. If the cyanoacrylate bonds too rapidly, then it can trap uncured cyano material that will reduce the final bond strength.

It is very difficult to slow down the setting process of the cyanoacrylates, so the best option is to obtain the most appropriate grade for your application.

Maximum Operating Temperature

Cyanoacrylate glue joints are slowly degraded at high temperature. Typically don't expect bonds to perform well above 180C.

extend the life (Do not mix the storage of adhesives with food!). Unopened bottles stored in a fridge should be allowed to return to room temperature before use. Once open, keep cyano in a cool, dry place away from daylight. Keep the cap on the bottle or leave a purpose made micro tip on top. The glue will cure at the tip where it is in contact with moisture in the atmosphere and thus seal the bottle ready for next time. Remember, that it is moisture as well as heat that shortens the life of cyanoacrylate.

Finally, what not to do! Do not store your cyano bottle next to a bottle of activator. Fumes from the activator could cross contaminate and will shorten its life.

Tips for Getting the Best from Cyanoacrylate

To stop sneezing and eye irritation: choose a non-fuming, low odour grade or try placing a saucer of water close to where you are working.

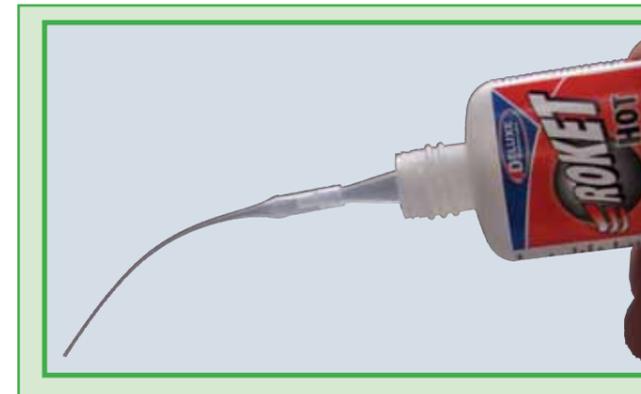
How to apply adhesive whilst reducing tip clogging: Squeeze the bottle gently as you pick up the bottle. While still holding the

curing the glue around it. **Avoiding blooming on clear plastics:** Blooming is caused when the cyano does not fully set and the remaining glue vaporises. This vapour can then react with the moisture present on the clear plastic surface to spoil it. You can reduce this effect in several ways:

- Warming the clear plastic surfaces to 'drive off' moisture.
- Using less cyano.
- Using a non-blooming grade that will eliminate the problem.
- Using an accelerator spray.

To stop caps getting jammed: Use some Teflon tape around the thread on the neck. Kits of spare caps and plugs are available from some makers if you are unlucky enough to jam one.

Using cyano accelerators (kickers): Use only when needed, as they will tend to slightly reduce bond strength. Avoid breathing their vapour. You can often remove the spray head of the pump type kickers and apply with a brush to avoid this.



Far Left: Thin tips can help the application of small amounts of cyano exactly where needed.

Left: For a strong joint where the fit is not so good, take a two-step approach: thick cyano 'squashed' into a thin layer, followed by a fillet of thick grade and a spray of accelerator/kicker.

Forces cure through cyano glue to fill gaps & enable fillets.

Storing Cyano Glue

Cyano glue is best stored in unopened bottle in a cool dry room, 5-10 C, away from daylight. Every 10C increase in temperature doubles the deterioration speed so storing unopened bottles in a refrigerator would

squeeze, apply the glue and return the bottle to upright and release the squeeze. This will draw air through the tip and clear it. Oval bottles are easier to squeeze and specially made micro tips help to dispense the glue where you want it. Using a metal pin to keep the tip clear may have a negative effect by

Using cyano with white glue: You can obtain the benefits of both PVA type glue and also cyano glue. Use cyano to tack the joint in place and then reinforce with the PVA type glue. Some manufacturers make thin penetrating 'white' glue that is ideal for strengthening and toughening the joint.



To assist dealers to keep a fresh stock of cyanos, Deluxe Materials have made a mix box with a full range of viscosities and types in one tray.

Best joints and fillets: For maximum bond strength, don't leave glued joints open for too long and avoid repositioning as this may weaken the joint. When using thick grades, apply glue to one surface & 'squash' the cyano glue into a thin layer. Add a fillet of thick grade & cure with a quick spray of accelerator.

Opening the bottle first time. In case there is excess pressure inside, hold the bottle away from your face and hold the tip against a solid surface when you cut it.

Bonding Foam: Because of its lightness, foam has replaced balsawood as an aeromodelling construction material. There are many types on the market and they are not always easy to recognize. To be sure foam will not melt in contact with cyano, use an odourless grade on one surface of EPS(styrofoam), EPO or Depron foams. Bring dry surfaces, previously treated with kicker, together for fast bond. Normal cyano may bond other types of foam e.g. on EPP, EPO. A surface primer such as Tricky Stick, is often helpful for gluing Plastic parts, and can be useful for EPO and EPP foam. As it is so difficult to identify unknown foams, always check your adhesives and sprays on scrap beforehand, giving enough time for any adverse reaction or set to take place.

Removing surface marks: There are specially made cyano de-bonders that will quickly dissolve away cured superglue marks etc. Blooming marks can be polished away with fine plastic polish.

Filling gaps over 0.5mm and creating strong fillets: Use a thick grade with a kicker to cure the glue. For larger gaps, use a special filler powder & add thin ca.

Cavities or lost material are easily replaced by this method.

Bonding smooth plastics: Abrade surfaces & use a kicker or primer to assist bonding smooth plastic surfaces e.g. polycarbonate acrylic.

Bonding shiny or oily plastics & other tricky materials e.g. EPP foam Polythene, silicone rubber, polypropylene, nylon. Use a surface primer to coat the surfaces and allow



Filling gaps can be achieved with thicker viscosity cyano, or by using a filler powder and thin cyano to penetrate through the filler.

to dry and apply cyano. Press together and hold. You may need to clean surfaces with cigarette lighter fluid or paraffin to ensure any mold release agent (used during the manufacture of the plastic) is removed before applying the primer.

Reinforcing joints: try using a small piece of photographic film behind joints or carbon tissue.

Advice for Treating Accidents

Stuck fingers: If you have glued your fingers together, simply immerse the bonded area in warm water. Then perhaps with the aid of

a teaspoon, roll or peel the surfaces apart. If necessary, try a specialist cyano de-bonder, working it into the skin or try nail varnish remover. Afterwards, wash skin thoroughly.

If accidents do occur and there is concern or doubt, please seek medical advice.

Ingested glue: It is almost impossible to swallow superglue as it solidifies instantly in the mouth and saliva will dissolve it in 24 hours. Although cyano glue is non-toxic DO NOT swallow the glue.

Eyelids: Consult your doctor. Cyano will dissolve in 1-4 days.

Burns: If large amount is spilled on skin it can burn. Wait for it to solidify, release and treat as normal burn.

Finally perhaps you didn't know... superglue has had many interesting uses outside modelling. For medical use it was first used for heart transplants by Dr Barnard and in the Vietnam War for wounds. However it was not approved for medical use until 1998 when a special 2 octyl grade was released.

Other uses for specialist formulations include:

- On ballerinas shoes to harden points.
- As a forensic tool to capture fingerprints on non-porous surfaces.
- For sticking corals in aquaria.
- Veterinary use – Stick horses skin on damaged hooves so then can continue to race.

I hope you've enjoyed this series of articles and have found them useful. I would



John Bristow (left) welcomes your editor on a visit to Deluxe Materials.

like to thank Andrew Boddington for his encouragement in asking me to write these articles. Both he and his father David have been great inspiration to us over the years.

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