

**Adhesive
problem?**

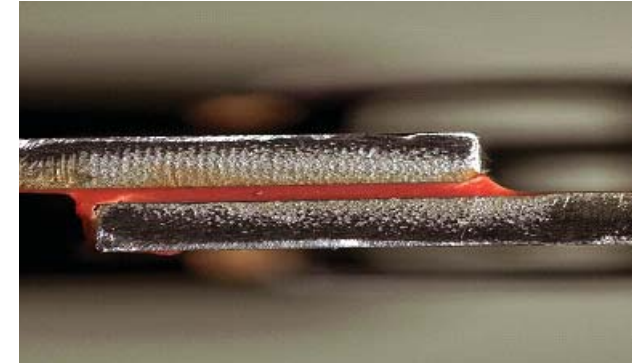
**What's
the
cure?**

Adhesive problem? What's the cure?

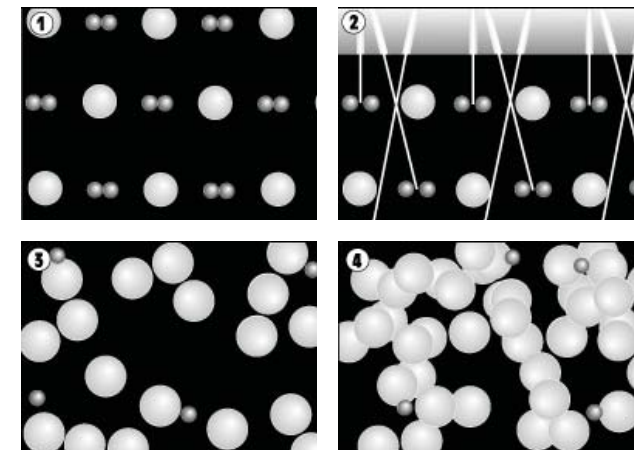
The use of adhesives for structural bonding is on the increase. For a successful assembly, the adhesive must “harden” in the bondline to provide a joint which is capable of bearing the forces to which it is subjected for its lifetime, whatever environmental factors are thrown at it. Understanding how this works is important both for adhesive selection, and specification of the bonding process.

Is this “hardening” called curing?

Not necessarily. There are a number of ways to get a liquid adhesive to become a solid. Some adhesives merely dry, when the solvent or water in them evaporate. Simple hot melt adhesives harden when cooled from a higher temperature. But we usually consider an adhesive to be cured when some form of chemical reaction takes place. The constituents (like monomers or oligomers) join up to become larger molecules (polymers). We call this chemical reaction “polymerisation”, “cross-linking” or “curing”.



Adhesive must harden in the bondline



Curing or crosslinking of a light curing adhesive

Can adhesives cure by themselves?

No, not really – you might find such an adhesive difficult to keep liquid in the bottle! There are three basic ways to get this chemical reaction started and continued until full cure. One way is to mix two or more components together.



Fit resin & hardener cartridges into dispensing gun



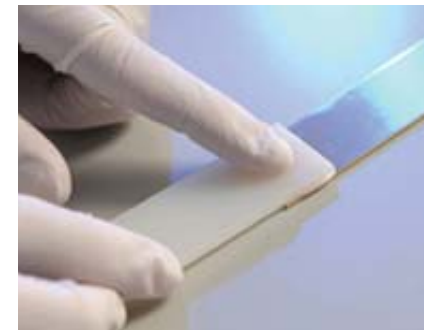
Attach recommended mixing nozzle to gun



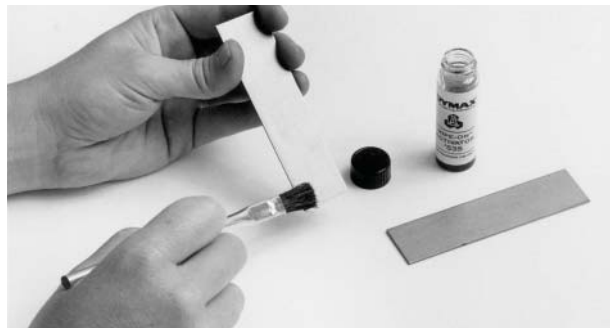
Squeeze trigger to dispense mixed media

Like the two little tubes of epoxy we have at home for DIY fixes?

Yes. Araldite® started selling two part epoxy for bonding in the 1940's, and it is a strong household brand in the UK. With an epoxy adhesive, the “resin” and the “hardener” are mixed which causes the cure, the speed of which can be anything from a few minutes to some hours. In industrial applications, two part structural adhesives are usually based on epoxy, methacrylate or polyurethane chemistries – different properties like flexibility, toughness, cure speed, viscosity or adhesion to different substrates will determine the correct choice for each application. To make mixing and application easier, the two parts are often packaged in side-by-side cartridges, with the capability to mix and dispense through a special nozzle.



Some acrylic adhesives use an activator, rather than a two part mix. Typically, the adhesive is applied to one substrate, and a film of liquid activator is applied to the other. Once brought together, the adhesive and activator mix to cause cure, which again can be very fast.



Apply activator to one substrate



Apply adhesive to other surface



Assemble

Sometimes this mixing can be a nuisance. Can't I have a single part adhesive?

Sure – but you still need to make it cure somehow. Another way to do this is to add energy. Single part epoxies require heat to cure, usually 120°C or more. This requires ovens or induction heating. Single part addition cure silicone is another example requiring heat. You can also use light energy to cure an adhesive. Light curing adhesives are single part systems, based primarily on acrylic or acrylated urethane chemistry (although there are epoxy systems). They are formulated with photo-initiators which react to UV and/or visible light to cause cross linking. The speed of cure is very fast (seconds). The limiting factor is that you must expose the adhesive to light whilst it is in the bondline, so one of the substrates must transmit light.



Adhesive cured with light

Can I cure single part adhesives without using an external energy source?

This is the third way – change the conditions. For example, a thread-locking adhesive will cure when it is placed on the threads of a bolt and the bolt is screwed into its hole. This is an example of an anaerobic adhesive. They cure in the absence of oxygen and in the presence of metal ions. Consequently, anaerobics

are used for metal bonding where you can change the conditions by removing the oxygen, like bonding gears to shafts.

Other single part adhesives cure when in the presence of moisture, like single part polyurethane adhesives, which are used as woodworking glues and construction sealants. One part silicone RTV sealants and adhesives cure under the action of atmospheric humidity. These are known as “condensation” curing, as a by-product is given off in the chemical reaction. Bathroom sealants based on silicones liberate acetic acid, but for technology applications, silicone condensation cure systems have been developed which have small amounts of non-corrosive by-product, safe on electronics, etc. Cure depth is limited to about 10mm.



Single part RTV silicone adhesive

What about superglue?

Cyanoacrylate adhesives (CAs) are sometimes known as “superglues”. They are unusual in that during their liquid state, they are desperate to polymerise, and are only prevented from doing so by the presence of an acidic stabiliser. To get them to cure, you need to neutralise this stabiliser – usually, the naturally occurring

moisture on the surfaces to be bonded is enough to do this, although there are other ways. The condition we are changing in this case is pH. Cyanoacrylate adhesives cure very quickly, but work best in thin section interfacially i.e. between two surfaces.

So the three ways are adding two parts together, adding energy and changing conditions. Are there any more ways to get an adhesive to cure?

Adhesive formulators have been very clever about mixing up these cure mechanisms to form hybrids – adhesives which cure in more than one way. Many two part adhesives will cure faster and more completely if you add heat. CAs have been introduced which also cure with UV light. Light curing adhesives have secondary cure mechanisms which include heat, activators or moisture. Thermosetting hot melt adhesives solidify when cool and cross-link as well.



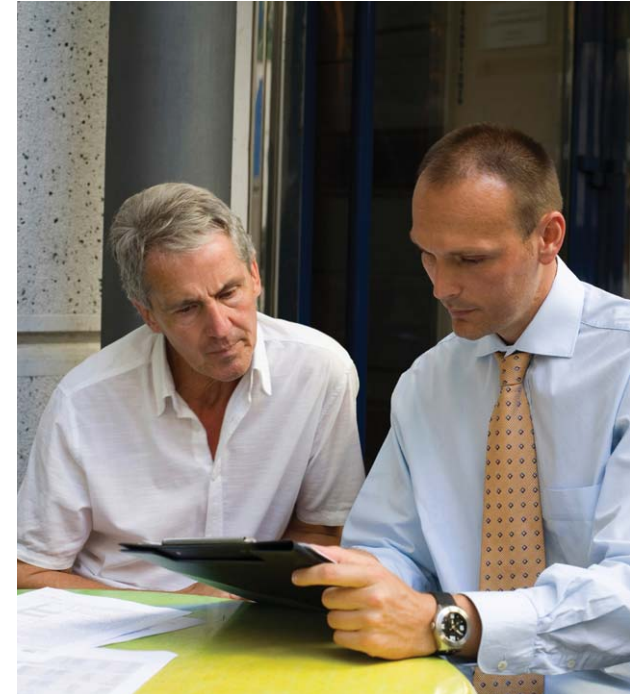
Single part cyanoacrylate adhesive



Adhesives must be practical to use

Sounds complicated! How do I choose?

Knowing how adhesives cure is just one part of the understanding you need to finding the right adhesive for your application. The adhesive must hold the bonded joint together, but it must also be practical to use in the assembly operation. Choice will depend on adhesive performance factors (operating temperature, environment, substrates to be bonded, forces, etc). Process efficiency can be optimised by material choice as well, considering cure type and speed, application methodology, and so on. Work with an adhesives supplier who can help you indentify the pertinent issues in your bonding project, and who can recommend with high confidence an adhesive to evaluate – for both optimal performance and optimal process.



Working with adhesives supplier

Information

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Contact us

For more information about structural bonding adhesives, please email info@intertronics.co.uk or call 01865 842842.

Complete information on our products and solutions is available at www.intertronics.co.uk

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