ADHESIVES

AND OTHER THINGS WE REALLY

DIDN’T WANT TO KNOW ABOUT

Sticky Words of Wisdom

or

Mother should have told me there’d be days like this

1 - WHAT AM I DOING HERE

2 - WHAT MY CHEMISTRY TEACHER NEVER TOLD ME

3 – HOW MUCH WOOD COULD A WOODCHUCK CHUCK IF A WOODCHUCK COULD CHUCK WOOD

4 - ITS A BIRD, ITS A PLANE, ITS SUPERGLUE

5 - 2 THINGS ARE BETTER THAN 1 - EPOXY

6 - POLLY WANNA WHAT?

7 - OPENING PANDORA’S BOX – LETS GLUE SOME PLASTIC

8 - YOU SHOULD HAVE TOLD ME IN THE FIRST PLACE

(1) WHY ME LORD?

I am a member of the Model Shipwrights of Niagara, a group of folks who specialize in building static model ships. During a moment of unconsciousness, I volunteered to do a presentation on adhesives, specifically for wood as that is the medium which is predominate in ship construction. During the research phase, I discovered the world of adhesives is not only huge but also very complex. I do not profess to be knowledgeable nor an expert but I do hope that this small presentation enables you to use whatever adhesive you require in a professional way.

IT SEEMS LIKE ONLY YESTERDAY

We tend to think of glue as a modern solution however we can trace glue back to around 5000 BC when it was used to repair broken ceramics and statues. From analysis we know that the glue was made from bones, hides, and the skin of animals. Other discoveries showed glue made from tree sap. We know that the ancient Greeks developed adhesives for use in carpentry, and created recipes for glue that included the following items as ingredients: egg whites, blood, bones, milk, cheese, vegetables, and grains. Tar and beeswax were used by the Romans for glue. Around 1750, the first glue or adhesive patent was issued in Britain. The glue was made from fish. Patents were then rapidly issued for adhesives using natural rubber, animal bones, fish, starch, milk protein or casein. Despite the hard, water sensitive nature of animal derived glue, this remained the only available substance until World War I, when milk derived glues were first invented. From the 1930s, the advancement of the plastics industry resulted in the development of additional adhesives and glues. These substances were stronger, stickier, and waterproof compared to the animal glue of the past.
We used to refer to race horses who finished last as ‘going to the glue factory’, there may have been a lot of truth to that phrase.

WHAT AM I DOING HERE?

So what is the best glue to use and why don’t we all just use it? What glue should I use for my project. Unfortunately, the answer is ‘it all depends’. If you search the Internet for the strongest glue in the world, the only answer that I found is ‘it all depends’. There is no one stop all encompassing answer for the correct adhesive. We have to start with – what do you want to glue to what? The next thing we need to understand is how various types of glues work and what their characteristics are so that you can pick the correct solution.

YOUR GOING TO GLUE WHAT TO WHAT?

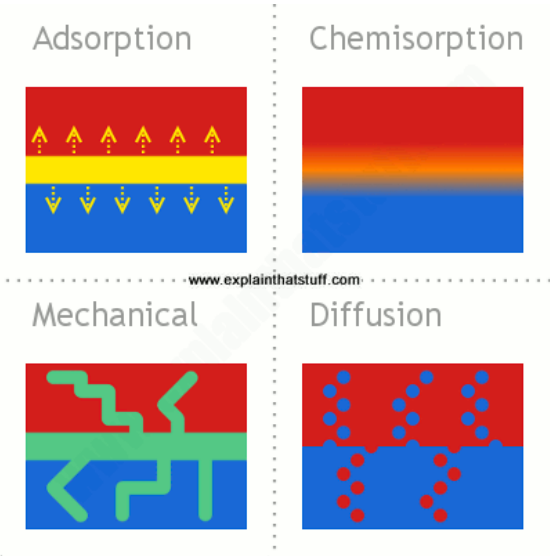
Lets think about all the things we can glue today. Just about anything you can think of can be glued to itself but the real problem is gluing two different materials together in a strong bond. For example, when I built a workshop in my old house I used a concrete adhesive to glue the 2/4’s onto the cement wall. The Boeing Dreamliner is a good example of something that is glued together. In the future, its possible that the car you drive will be glued and not welded.

In order to find out the best glue, there are web sites on the Internet to assist you. Here is an example of one that will assist you - http://www.thistothat.com/

(2) What my Chemistry Teacher Never Told me… sigh

Glue works by binding two materials together. It does this through producing a small surface chemical reaction and bond between the materials. For any glue, there are two forces at work that we need to understand. First there is cohesive force (the process involved is called cohesion) which is the force that keeps similar atoms together. For example, water molecules (two atoms of hydrogen and one atom of oxygen joined together) naturally stick to one another, so they clump together in big droplets. Adhesive force (the sticking process is called adhesion) would be for different atoms to stick together, for example water to glass.

Adhesive and cohesive forces are also at work in glues. Let's say you want to stick together two bits of wood, A and B, with an adhesive called C. You need three different forces here: adhesive forces to hold A to C, adhesive forces to stick C to B, and cohesive forces to hold C together as well. The first two are pretty obvious: the glue has to stick to each of the materials you want to hold together. But the glue also has to stick to itself!



Four theories of how things can stick. Clockwise from top left: 1) Adsorption is a surface sticking effect caused by small, attractive forces between the adhesive (yellow) and the substances it's sticking (red and blue). 2) Chemisorption involves chemical bonds forming between the adhesive (orange) and the substances it's sticking together. 3) Diffusion sticks two things together when molecules cross the boundaries from one into the other and vice-versa. 4) Mechanical adhesion happens when a glue (green) fills the space between two substances and the cracks inside them, creating a strong physical bond.

Adhesives are designed to work when they leave the tube—and not before. Different adhesives achieve this in different ways. Some are dissolved in chemicals called **solvents** that keep them stable and non-sticky in the tube. When you squeeze them out, the solvents quickly evaporate in the air or get absorbed by the surfaces you're sticking to, freeing the adhesives themselves to do their job. Plastic modeling glue works like this. It contains molecules of polystyrene in an acetone solvent. When you squeeze the tube, the glue spurts out and you can usually smell the very strong acetone as it evaporates. Once it's gone, the polystyrene molecules lock together to make strong chemical bonds. Glue doesn't smell when it's dry because all the solvent has vanished into the air. Some glues (such as synthetic, epoxy resins) have to be mixed together before they work. They come in two different tubes, one containing the synthetic resin and the other containing a chemical that makes the resin harden. The two chemicals are useless by themselves but, mixed together, form a tough, permanent adhesive.

Basic Glue Types

Polyvinyl Acetate (PVA) Adhesive: A popular water-based domestic and commercial glue, PVA is generally best suited for where it can be spread over a larger surface. While it has a weaker hold than clear adhesives, it is an easy-to-use, inexpensive option for adding finer details to a model. It is also quick to remove, if you do make any mistakes.

Aliphatic Glue: Also known as wood glue, aliphatic is similar to PVA, but tends to soak into joints better and thus forms a stronger bond. It also has a higher resistance to water and sand, and sets quicker than PVA. As should be obvious by its common name, it is perfect for bonding wood to wood.

Canopy Glue: Ideal for bonding plastic to plastic, these glues have the benefit of easy application and a clear finish – in other words, no nasty white marks once the glue has dried on your model parts. While the bond isn't super strong, it is a handy tool for smaller builds.

Super Glue or Cyanoacrylate (CA): A widely used glue in the world of model making, it is useful for bonding metal to metal or metal to plastic. This tends to set rapidly, so extra care should be taken when lining up parts to avoid a tricky fix later.

Epoxy Resin: A two-part glue made-up of an adhesive and a hardener, epoxy resins will bind almost any two surfaces together. Mixing is required prior to use, and drying time will generally be slower than super glues, although there are faster mixes available. The end result is a very strong bond.

(3) – WOODY WOODCHUCK

PVA glue

Polyvinyl acetate (PVA) glue is super common — in fact, if you have a bottle of glue in your house, it’s probably this. White glue, yellow glue and bottles of “wood glue” are usually all PVA glue. Some, like Titebond III, are even waterproof. PVA glue is well liked because it's so easy to come by, but it's not always the best choice. Dried bits of PVA glue can interfere with your finish if you’re not careful to get rid of it all.

The 3-Types of Wood Glue

Wood glue is just a classification of glue rather than the actual glue itself. There are actually three primary types of wood glue that you may be able to find at your local craft or construction store.

Aliphatic resin. This is the traditional yellow glue that may come to mind when you think of wood glue or carpenter’s glue. Yellow glue is a little bit stronger than traditional white glue, but it dries quicker and holders stronger. You can also sand over most yellow glues without having any real problems if you plan on repainting the area, but it is resistant to wood stains.

Urea formaldehyde is a plastic resin glue that offers water resistant properties. Plastic resin glue is recommended for laminating layers of wood and for gluing structural joints. It is water resistant but not waterproof. It is highly resistant to any type of paint or paint thinners. This type of wood glue also takes around 30 minutes to obtain a good hold on the two surfaces, but once it does obtain a bond it holds very tight.

Resorcinol glue is one of the most durable types of wood glue. It is 100% waterproof so it makes a great option if you need to seal up or fix any outdoor furniture, concrete, or heavy duty repairs like boats, ATVs, etc. When applying resorcinol glue, make sure that you are keeping it away from moisture until it dries. Clamping is required; curing time is 8 to 24 hours, depending on humidity and temperature.

Hide glue

Yes, this one comes from animal hides. This tried and true option has been around for centuries, and it's also what hot glue is made from. Hide glue is handy since it can be heated up and applied to the work piece with a brush.

There's also a version of hide glue called liquid hide glue that comes in a bottle, ready to go. You can use it just like PVA glue, and it won't interfere with finishes if you fail to get every last bit of dried hide glue off the wood. This is a favorite and it's a champion all-around glue for most projects unless you need something waterproof.

Hide glue is commonly used to restore antiques. One of its best properties is that new hide glue sticks to old hide glue, unlike PVAs. That's why loose joints on antiques originally assembled with hide glue can be re-glued without paring the joint back to bare wood.

Another nice thing about hide glue is that parts glued together with hide glue can be separated with steam or hot water. That is why antique and instrument restorers like this glue. Antiques can be disassembled for restoration then easily reglued.

Typically, to prepare hide glue, granules are melted in a glue pot with water. However, you can buy cold, pre-mixed hide glue. It has a shorter shelf life but still works well. Hide glues typically have a 10 minute open time, clean up with water, and dry translucent. Titebond Liquid Hide Glue is a good choice.

Hide glue is made from rendered animal collagen and is one of the oldest known forms of adhesive. Traditionally, "hot" hide glue comes in small granules that are melted in a double boiler and applied while warm. As the glue cools, the bond gets stronger. Once cured, this glue produces a strong bond that is on par with modern PVA glues.

This glue has been making a resurgence in some traditional woodworking circles because it has a lot of desirable properties: it’s non-toxic, it can be stained, it has strong initial tack that can be achieved via a rub joint (rub two coated pieces together and they will stay together), and it is available in several gram strengths (higher gram strength equals stronger glue joint) and color grades. This is a great glue for general furniture, musical instruments, and veneer work. High-quality hide glue does not smell bad and is available from several reputable suppliers. Once cooled, the unused glue can be reused if reheated. If you don’t want to invest in a double boiler, there are some manufacturers like Old Brown Glue and Tite-Bond that sell a liquid hide glue that can be used at room temperature, has most of the same properties of hot hide glue, and has a longer open (working) time. The biggest reason for hide glue’s popularity is its reversibility; if you apply heat to the joint, the glue will loosen. This has allowed many antique pieces to be repaired and restored over the years.

Hot Melt Glue

Hot melt adhesive (HMA) or simply "hot glue" is great for temporary jigs and fixtures. The glue comes in a cylindrical stick that is fed through a "glue gun" with an electric heating element that melts the glue. As you pull the trigger on the gun, glue is dispensed. This thermoplastic glue cools and sets quickly, and can be removed either by popping it off or by heating it with a heat gun or a similar heat source.

(4) - Its a bird, its a plane, its Superglue

The original patent for cyanoacrylate was filed in 1942 by Goodrich Company as an outgrowth of a search for materials suitable for clear plastic gun sights for the war effort. In 1942, a team of scientists headed by Harry Coover Jr. stumbled upon a formulation that stuck to everything with which it came in contact. The team quickly rejected the substance for the wartime application, but in 1951, while working as researchers for Eastman Kodak, Coover and a colleague, Fred Joyner, rediscovered cyanoacrylates. The two realized the true commercial potential, and a form of the adhesive was first sold in 1958 under the title "Eastman #910" (later "Eastman 910"). The name 910, comes from counting to 10 as the inventor determined that the product sets between 9 and 10 seconds.

During the 1960s, Eastman Kodak sold cyanoacrylate to Loctite, which in turn repackaged and distributed it under a different brand name "Loctite Quick Set 404". In 1971 Loctite developed its own manufacturing technology and introduced its own line of cyanoacrylate, called "Super Bonder". Loctite quickly gained market share, and by the late 1970s it was believed to have exceeded Eastman Kodak's share in the North American industrial cyanoacrylate market. National Starch and Chemical Company purchased Eastman Kodak’s cyanoacrylate business and combined it with several acquisitions made throughout the 1970s forming Permabond. Other manufacturers of cyanoacrylate include LePage (a Canadian company acquired by Henkel in 1996), the Permabond Division of National Starch and Chemical, Inc., which was a subsidiary of Unilever. Together, Loctite, Eastman and Permabond accounted for approximately 75% of the industrial cyanoacrylate market. As of 2013 Permabond continued to manufacture the original 910 formula.

In its liquid form, cyanoacrylate 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 a density of 1.1 g/ml. Ethyl 2-cyanoacrylate ($C_6H_7NO_2$) has a molecular weight equal to 125 and a flashpoint of >75°C. To facilitate easy handling, a cyanoacrylate adhesive is frequently formulated with an ingredient such as fumed silica to make it more viscous or gel-like. More recently, formulations are available with additives to increase shear strength, creating a more impact resistant bond. Such additives may include rubber, as in Loctite's *Ultra Gel*, or others which are not specified.

In general, cyanoacrylate is an acrylic resin that rapidly polymerises in the presence of water (specifically hydroxide ions), forming long, strong chains, joining the bonded surfaces together. Because the presence of moisture causes the glue to set, exposure to normal levels of humidity in the air causes a thin skin to start to form within seconds, which very greatly slows the reaction. Because of this cyanoacrylate is applied thinly, to ensure that the reaction proceeds rapidly for bonding.

The reaction with moisture can cause a container of glue which has been opened and resealed to become unusable more quickly than if never opened. To minimize this reduction in shelf life, cyanoacrylate, once opened, can be stored in an airtight container with a package of silica gel desiccant. Another technique is to insert a hypodermic needle into the opening of a tube. After using the glue, residual glue soon clogs the needle, keeping moisture out. The clog is removed by heating the

needle (e.g. with a lighter) before use. The polymerisation is also temperature-dependent: storage below the freezing point of water stops it, so keeping it in the freezer is also effective.

How It Works

Unlike traditional adhesives which are water-based, cyanoacrylate glue is composed of an acrylic resin. The main ingredient in cyanoacrylate glue is cyanoacrylate, which is an acrylic monomer that transforms to a plastic state after curing.

Cyanoacrylate glue also differs from traditional glue, due to its special bonding conditions. This is because cyanoacrylate glue can only bond with a surface when there is moisture present. This means if the cyanoacrylate glue is placed on a perfectly dry surface, it will not stick to the surface or form a bond.

In contrast, when any amount of moisture is present, the molecules in the cyanoacrylate glue will react with the moisture to form tight chains in between the two surfaces in contact. This reaction generates heat and occurs instantly, which differs from traditional glue bonding that occurs by evaporation of the base fluid.

Curing Process

Curing is an important process for all glue types and should be considered when choosing the right type of glue for specific applications.

Broadly speaking, curing is defined as the process where a chemical reaction takes place to form harder and tougher linkages in a chemical substance. For some materials, this process will only occur at specific temperatures or humidity levels. For glues, curing can be facilitated by radiation, heat, moisture or UV light.

As mentioned above, curing for cyanoacrylate glues is facilitated by the presence of moisture and occurs almost instantly at ambient temperatures. The bonds formed during curing are also extremely rigid, hence its nickname of “super (strong) glue”.

It cures by moisture. When applied it instantly starts to cure by forming a film on the top so do not use a lot. There are activators that can be applied to quicken the curing process

CA for Model’s

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 Sigment 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).

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.

Thin 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.

Medium CA - Medium CA has a viscosity somewhere in between thick and thin. Sometimes the directions will specify this type of glue for special 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.

Thick CA - Thick CA has a very thick viscosity. This is sometimes referred to as gap filler CA. This type of glue is good for joints where there may be small gaps between the wood. Thick CA forms a stronger bond than thin CA. It also takes longer to cure which gives you longer to position the pieces correctly before it cures, curing time is about 1 - 2 minutes.

Accelerator

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. Joints repaired by kicker can be very brittle.

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.

CA Debonder

Today there are commercial debonders available to ‘melt’ a CA bond. You can apply a liquid and after an amount of time the bond can be broken.

Saftey

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.

(5) – EPOXY, TWO HEADS ARE BETTER THAN ONE

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.

Use an epoxy when the joint requires exceptional strength. 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 gooey 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.

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.

(6) - POLYURETHANE GLUE

Polyurethane glue is activated by moisture, and naturally swells as it dries. It does dry very hard and quickly (plus it's waterproof!), but dealing with dried polyurethane glue can be rough for finishes. It expands deep into material, providing very tough, weather and waterproof bonds.

What are Polyurethane Adhesives Used For?

Whatever the exact composition, polyurethanes have some things in common. They are STICKY. Reading the claims of PU adhesive manufacturers is like reading a who's who of materials. Very few things are omitted. Polyurethane glues will work on just about all normal materials, porous or not. Wood, metals, rubbers, cured epoxy, leather, tile and glass, many plastics, concrete and brick, the list goes on. It does not work well on polypropylene, polyethylene or on such substances as teflon or silicone. Nor does it like waxy or oily surfaces. Polyurethane based adhesives can set solid and relatively inflexible, or can remain rubbery and flexible.

Most polyurethane adhesives set more solidly without being brittle. They can be sanded, and a fine tooth saw will cut through the glue without dulling the blade as epoxy might.

What are the Advantages of Polyurethane Glue?

- It can stick to most things and can glue different materials together. It is successful in bonding non porous materials such as metal to wood, or mirrors to walls.
- Some compositions have a nice work time of 20 or so minutes. This allows for leisurely working and clamping time.
- Depending on the glue it can set quite quickly after clamping and allow the user to continue work as the glue completes its curing.
- A major advantage over many adhesives is its ability to set in high moisture conditions. In fact it needs moisture to set and will cure faster in conditions where other glues, such as epoxy, cannot be used.
- It is waterproof. Some brands are more than others. Passes ANSI Type I & II water-resistance testing. Vice brand makes SUPERGRIP, a marine polyurethane. Polyurethanes are generally not recommended for long term immersion in water or use below the waterline unless protected by paints or other protection.
- It requires no mixing or measuring and can be used directly from the bottle.
- It is available in several different viscosities and packaging. It is available in caulking tubes with filler which makes it stay and not sag, squeeze bottles, tubes, and single use package.
- Polyurethane is available as a hot melt glue that sets and holds parts together without the need for clamping. Once the glue has cooled and set it continues to cure for several days to attain its full strength.
- If properly applied and cured polyurethane makes a strong bond.
- Will set in a wide range of temperatures.
- Suitable for outdoor projects Polyurethane has good UV resistance.

- Does not contain solvents and is a low Volatile Organic Compound producer. 100% solids so it does not tend to crack and shrink as it sets.
- It can be sanded (non clogging), stained and painted. Cleanup of squeezed out extra glue can be chiseled off easily. Set glue is slightly flexible and not brittle.
- Food safe after curing.
- Once set it will not creep.

What are the Disadvantages of Polyurethane Glue

- It is not as strong as epoxy. On wood it is stronger than the wood so its strength is not an issue but on metal, epoxy provides a stronger bond.
  It compares to other wood glues. Great claims have been made but tests seem to show about equal holding power. Polyurethane had better end grain gluing capability though because of better glue penetration. Because once cured it is stronger than the wood it is gluing, strength is not an issue unless it has foamed.
- Parts being glued with polyurethane need to have a tight fit to be strongly joined. Polyurethane is not a good gap filler. Although it is sometimes advertised as gap filling, tests show that strength is reduced when the glue line is thick. When setting it froths up and the froth, although gap filling, is not strong. Some formulations have filler that allows for some gap filling.
- In very dry areas it requires moisture to set or it can set very slowly and not reach it's full potential.
- Because it is sensitive to humidity in the air and wood, setting times can vary considerably.
- It tends to foam and squeeze out. If not clamped the parts can be forced apart by the foam, weakening the joint. The foam gives the illusion of gap filling, but it is not strong. Foaming is greater when there is a lot of moisture. Some compositions foam more than others which are practically foam free such as the construction adhesives as PL Premium.
- After curing it is very chemically inert and safe but the intermediate phases are toxic, irritating or carcinogenic. This means polyurethanes have to be handled carefully, kept off your hands and not breathed in too much.
  Warnings include: Contains isocyanate containing polymers. Contact causes eye irritation. Prolonged or repeated skin exposure may cause allergic reaction, irritation and sensitization. Contact may stain skin. Do not allow eye contact. Avoid prolonged or repeated contact with skin.
- Some brands and compositions are expensive.
- Polyurethane has a limited shelf life, less than a year, and once opened can go off quickly if moisture gets in.
- It is messy and sticky to use and always seems to get on everything.
- Polyurethane is difficult to clean off hands, (gloves are highly recommended). Acetone or lacquer thinner can be used to clean tools while still uncured.

(7) Opening Pandora's box

LETS GLUE SOME PLASTIC

There are so many different types of plastics and so many different types of glue on the market that it's often very hard to figure out what to use. First off you have to know what kind of plastic you want to glue then find the formula that will work correctly with the plastic.

Here is a list of common plastics that we encounter on a daily basis. I found this web site http://www.thebestglueforplastic.com/ which has a wealth of information about gluing plastic to plastic as well as plastic to other materials. There is even a tab that explains what the RIC (Resin Indentification Code – the triangle on the bottom of the plastic that tells you what kind of plastic you are dealing with) numbers are and the best glue to use with it.

Acrylic (PMMA)

Most of us know acrylic plastic or poly(methyl meth*acrylate*) by one of its brand names, Plexiglas®. It also goes by Lucite®, Perspex®, Acrylite® and a host of other names. Acrylic is a thermoplastic that can be molded into many different forms with heat, hence the term, "thermo". Usually transparent, you can also find it translucent or in many different colours.

In sheet form it is quite shatter resistant so it often replaces glass.

ABS

Black plastic pipes! Isn't that the first image that jumps to mind when you hear the term, ABS? Acrylonitrile Butadiene Styrene. A very tough plastic with high impact resistance, ABS is also a thermoplastic that can be formed by injection molding into many more interesting and useful things.

This amazing plastic is also used to make whitewater canoes, toys like Lego®, luggage, protective headgear and when ground down really, really fine it's used to add colour to tattoo inks. With very high shock absorbing qualities, it's ideal for car bumpers and the heads of golf clubs.

Polycarbonate (PC)

This type of plastic is similar but a lot tougher than acrylic. It won't crack as easily and unlike acrylic it can be reformed at room temperature. It is also more durable in extreme temperatures which is why it's used for windscreens on snowmobiles in the bitterly cold Arctic. CDs, DVDs and Blu-ray discs are all made from polycarbonate. You'll find it in swimming goggles and protective visors and police riot gear. Eye glass lenses are often made from this material because it also protect eyes from UV radiation.

Polyethylene [PET, PETE, HDPE, LDPE]

There are several types of polyethylene, which is one of the three most widely produced of all the plastics. The other two most widely used plastics are Polypropylene (PP) and Polyvinyl Chloride (PVC). A Coke bottle is made from PET or PETE or poly(ethylene terephthalate). Food containers, water bottles, buckets and frozen dinner trays are all made from PET.

High and Low Density PolyEthylene (HDPE & LDPE). Milk bottles and milk crates, laundry detergent jugs, plastic films, kayaks and some toys are made from HDPE.

LDPE goes into making things like squeeze bottles for ketchup, wire insulation, some trash bags and bags for storing food.

PolyPropylene [PP]

The real question is, “What is NOT made from polypropylene?!” From banknotes to bottles this thermoplastic polymer is used to make so many things it'll make your head swim. 'Paper' money, floating rope, car batteries, pill bottles, pitchers, carpets & rugs, slide & negative protectors, model aircraft, chairs, cups, reusable containers, bottle caps, filters, diapers, drinking straws and lab equipment such as vials and face masks are all made from PP. Going for a walk in sub-zero temperatures? Don’t forget your polyproylene thermal underwear.

PolyStyrene (PS)

We know it as Styrofoam®. Although mostly used for wall insulation, expanded polystyrene is still used for take-out containers and food packaging. Glued together it can be carved and shaped for use as supports for arts and crafts projects.

Non-expanded or extruded polystyrene is hard and is made clear or in a variety of colours. The next time you take out a CD or DVD from its "jewel case" you'll be handling hard PS.

It’s also used for packing material – those annoying little “peanuts” that get all over the place - plastic plates, cutlery and disposable razor blades.

PolyVinyl Chloride (PVC)

There’s no mistaking that slightly nauseatingly sweet smell of PVC like you get from those new shower curtain liners. This, more flexible or 'plasticized' form of PVC, is often used to replace rubber, as imitation leather, for signs, beach balls and even clothing.

The more rigid or 'unplasticiezed' form of PVC, or uPVC, is used for bank and credit cards, bottles and window frames and non-food packaging. But most of it is used in sewage pipe for grey water and for irrigation.

Thermoplastic Polyurethane (TPU) *bridges the gap between rubber and plastics.*

The soles of running shoes, skateboard wheels are likely made from TPU. TPU is elastic enough to even out the little bumps in the road, yet it’s tough enough to resist oil and grease and won’t wear out even after prolonged use. Also transparent, thermoplastic polyurethane is used to make swimming goggles, film and sheet plastics and clear flexible tubing.

PolyLactic Acid (PLA)

Polylactic acid is made from natural foodstuffs like cornstarch, sugarcane or tapioca roots. PLA is the second most consumed plastic on the planet and that’s a good thing since it won’t be around forever once it’s thrown away. PLA's eco-friendliness makes it ideal for compost and recycling bags, tea bags, disposable cups and shrink-wrap for food packaging. And because it degrades to a harmless lactic acid, PLA is also used for medical implants and supports for regenerating bone.

3D Printing

3D printing is becoming more popular as printers become cheaper and easier to use. In model making, there is an abundance of pieces available on the Internet that modelers might find easier to print than to make. You need to research what plastic material the print tube is made of so that you can use the appropriate glue. The most common tubes today are made of ABS and PolyLactic BUT you need to be sure before you glue.

A few words about Model Kits

The vast majority of model kits made today are made from plastic (polystyrene). Most modelers will, sooner or later, come across other materials and cast polyethylene resin is one of these. Working with polyethylene resin requires different methods and products. Resin parts are cast from a liquid and may well come still attached to the casting block.

Standard polystyrene cement which is perfect for conventional styrene models is absolutely useless for resin parts. Poly cement works by slightly dissolving the styrene plastic, but it will not dissolve resin and so will not work at all. When gluing resin parts to each other, or to plastic, you will need to use either two-part epoxy glue or cyano (superglue) adhesive. Both of these work well, so it is down to individual preference.

Once you have glued the parts together, there may be a need for filler. The normal fillers intended for polystyrene such as Squadron ‘Green Stuff’ and ‘White Stuff’ will not adhere to resin because they are designed to ‘melt’ the surface of polystyrene. This does not mean that they cannot be used in certain situations, but you should be aware that they may flake away if spread thinly. Epoxy putties such as Milliput, or other fillers that have a natural tackiness, should normally be used in preference when filling resin parts.

When gluing two styrene parts then either poly cement, cyano or epoxy glues can be used. When gluing resin or metal parts then poly cement can NOT be used, but that still leaves epoxy cement and thin, medium or thick cyano.

(8) - YOU SHOULD HAVE TOLD ME IN THE FIRST PLACE

HINTS AND TIPS

When you're choosing your glue, here are a few tips to take into consideration. So make sure to ask yourself these questions before selecting:

- Do you need the glue to be waterproof?
- How long you have to work with the glue before it starts to set up?
- How much time do I need for drying?
- Do you need to fill a gap between pieces of wood?
- If you are going to paint over the bond, will the paint adhere to glue?
- You need to consider where the joint is. Does it need to be sanded? What strength is required for the joint.
- What kind of clamping system will I need to hold the pieces in place?

Probably the most important thing is to prepare the surface. Make sure that the surface is clean and for most adhesives the surface needs to be dry. It is important that you read the manufactures instructions.

USE THE CORRECT AMOUNT OF GLUE! Using too little glue will not allow the chemicals to penetrate the material and create a good bond. Using too much glue means that there could be a gap between the surfaces which will not create a strong bond.

Ooops, I made a mistake

As with any of life’s endeavors, mistakes or accidents will inevitably occur during your model making adventures. Sometimes parts don’t quite line up during the gluing stage, or worse still, a misread instruction could leave you with the wrong pieces stuck together.

So how do you get your parts apart to start again?

When it comes to using PVA or wood glues, an easy process is to use a paintbrush dipped in hot water. Simply paint the water onto the glued areas, and in a couple of minutes the glue should soften in the joints and come apart with relative ease. Following a brief clean up process, you should be ready to re-apply glue to where it needs to go.

Super glue is a completely different beast, and there are a couple of techniques available to get the desired result. Firstly, you can carefully use a hobby knife or scalpel to cut the bonded area and

separate the parts. This works better on larger pieces, but is not ideal for Photo-Etch pieces which tend to be more delicate.

Luckily, super glue melts at around 75 degrees Celsius, so you can use steam from a kettle to melt the glue. The process depends on what type of material you need to separate. Once the kettle has boiled, let it cool slightly then pour into a suitably sized container and immerse your bonded parts. Using clamps or pliers, gently pull and nudge the parts until they separate. Just remember that removing the parts from the boiled water will cause the glue to cool and harden again quickly.

Acetone or nail polish remover is great when trying to separate metal to metal bonds, and will dissolve the glue completely over time. Unfortunately this will not work for metal to plastic or plastic to plastic bonds, as the acetone will dissolve the plastic as well.

In the unwelcome event that you stick your fingers together, acetone is your best course of action. It will evaporate upon touching your warm skin though, so either use a little more or mix it with some Vaseline (50:50) for a more reliable mixture that won’t disappear.

AND FINALLY, YES ITS THE END

Most of this stuff I did not create myself. I spent time on the Internet researching then editing the material to hopefully make it helpful and easier to read. Its hard to believe that at one time we did things without the Internet but we managed to stumble along and do a few things that worked. There is TONs of information out there BUT please beware that not all of it is the Gospel Truth. I encourage you to search and read to try and find some kind of common useful information that is applicable to your situation. Keep an open mind and be willing to learn new stuff.

Ron Campbell
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