

LEARN-IT: Adhesives

This Adhesive and Material Compatibility Chart was Developed by the Massachusetts Institute of Technology.

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D-Lab

	Wood/ Plywood	Metal	Rubber	PVC*	Glass	Plastic*	Fabric, Paper, Leather
REACTIVE	Epoxy	Epoxy	Epoxy	Epoxy	Epoxy	Epoxy	Epoxy
	Acrylic	Acrylic	Acrylic	Acrylic	Acrylic	Acrylic	Acrylic
	Urethane	Urethane	Urethane	Urethane	Urethane	Urethane	Urethane
	Polyurethane	Polyurethane	Polyurethane	Polyurethane	Polyurethane	Polyurethane	Polyurethane
	Cyanoacrylate	Cyanoacrylate	Cyanoacrylate	Cyanoacrylate	Cyanoacrylate	Cyanoacrylate	Cyanoacrylate
	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone

NON- REACTIVE	PVA	PVA	PVA	PVA	PVA	PVA	PVA
	Contact Adhesive	Contact Adhesive	Contact Adhesive	Contact Adhesive	Contact Adhesive	Contact Adhesive	Contact Adhesive
	Hot glue	Hot glue	Hot glue	Hot glue	Hot glue	Hot glue	Hot glue
	Construction adhesive	Construction adhesive	Construction adhesive	Construction adhesive	Construction adhesive	Construction adhesive	Construction adhesive

* PVC is best adhered to itself with a solvent-based adhesive that chemically "melts" the PVC together.

* Most plastic adhesives only work with particular plastics. Confirm that the adhesive will work with your plastic.

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D-Lab

	Canvas	Fiberglass (FRP)	Poly-carbonate	Plaster	Ceramic/ Brick	Concrete*
REACTIVE	Epoxy	Epoxy	Epoxy	Epoxy	Epoxy	Epoxy
	Acrylic	Acrylic	Acrylic	Acrylic	Acrylic	Acrylic
	Urethane	Urethane	Urethane	Urethane	Urethane	Urethane
	Polyurethane	Polyurethane	Polyurethane	Polyurethane	Polyurethane	Polyurethane
	Cyanoacrylate	Cyanoacrylate	Cyanoacrylate	Cyanoacrylate	Cyanoacrylate	Cyanoacrylate
	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone

NON-REACTIVE	PVA	PVA	PVA	PVA	PVA	PVA
	Contact Adhesive	Contact Adhesive	Contact Adhesive	Contact Adhesive	Contact Adhesive	Contact Adhesive
	Hot glue	Hot glue	Hot glue	Hot glue	Hot glue	Hot glue
	Construction adhesive	Construction adhesive	Construction adhesive	Construction adhesive	Construction adhesive	Construction adhesive

* Concrete itself can act as its adhesive

Reactive adhesives

bond through a chemical reaction – often used structurally



Epoxy

Two-part curing

Strongest structural adhesive
(vs. urethane and acrylic) – high shear and peel strength

Highest temperature resistance
(vs. urethane and acrylic)

- Hardens between 2 – 60 min
Gains full strength in 24 hours
- Do NOT clamp
clamping may actually weaken the bond
- Cures under a wide range of temperature and humidity
(vs. all other adhesives)
- Excellent resistance to solvents, salt water, UV light, impact
- Good for filling spaces between surfaces
- Common brands: Loctite, Devcon, JB Weld, Titebond, 3M Scotch-Weld



Acrylic

Two-part curing

High-strength bonding without the surface preparation (vs. urethane and acrylic)

Bonds to a wide variety of materials
Even hard-to-bond plastics and oily metals

- Hardens within 3-20 min
Gains full strength in 8 to 48 hrs
- No need to clamp
- Tolerates moisture and dirty, unprepared surfaces
- Good for filling spaces between surfaces
- Common brands: 3M Scotch-Weld, Loctite, Lord



Silicone

Cures with water on the piece or humidity in the air

Used as a **sealant** – only has enough adhesive capabilities to hold onto the two pieces which it is sealing between

- Hardens in 20 – 40 min
Gains full strength in 24 – 72 hours (~2mm thickness with moisture in air)
- No need to clamp
- Excellent resistance to temperature extremes, weather, water, chemicals
- Good for filling and sealing spaces
- Stays very stretchy in most conditions
- Good for vertical and overhead applications because they don't run
- Speed up the curing process by elevating the temperature
- Common brands: Loctite, 3M, Permatex, Dow Corning



Urethane

Two-part curing

Highly elastic bond
Use when flexibility between dissimilar materials

- Hardens in 2 – 120 minutes
Gains full strength in 6 hours to 7 days
- No need to clamp
- Impact resistant and durable
Use for energy absorption
- Lower cost (vs. epoxy and acrylic)
- Common brands: Devcon, Loctite, 3M Scotch-Weld



Polyurethane

Cures with water on the piece or humidity in the air

Swells as it cures

- Hardens in 20-30 minutes
Gains full strength in 6 hours
- Apply in a thin layer and clamp
- Good moisture-resistance
- Sandable and paintable
- Works on most porous and non-porous surfaces
- Common brands: Gorilla Glue, Titebond



Cyanoacrylate (Super glue)

Cures with water on the piece or humidity in the air

For the best adhesion, dab the pieces to be glued with a damp cloth before adding the super glue

The reaction is exothermic (it releases heat as it reacts), so be careful when gluing fabrics such as cotton/wool because they could catch fire

Not actually used structurally due to its brittleness (low shear strength)

Use for small repairs that are not subject to much stress or movement
Use where the fit must be tight
Capillary action can draw in the glue into where there is little space for a thicker glue

- Hardens in 5 – 30 seconds
Gains full strength in 2 hours

Common superglues may soak into the surfaces
...especially with wood – leaving little glue on the surface, reducing the strength of the bond

- Strongest when in a very thin layer and clamped

- Best on low-porosity materials
Not recommended to use on glass

Superglue can be used as a **temporary clamp** while stronger glue hardens by adding a small amount to the ends of the pieces being joined.

Added to baking soda, acts as a hard, lightweight filler adhesive

Common brands: Loc-Tite, Permabond, Eastman, Krazy glue

Main types of reactive adhesives

Reactive **two-part** adhesives: base resin + hardener/curing agent → plastic or rubber

It transforms into a thermoset polymer via a cross-linking process.

The reaction requires mixing.

Reactive **one-part** adhesive: needs UV light, heat, or moisture

The one-part adhesive is a pre-mixed two-part adhesive, but the reaction needs UV light, heat, or moisture to begin
These are generally less common.

Non-reactive adhesives

bond through a physical change – often used non-structurally



PVA

polyvinyl acetate
(wood glue and white glue)

Cures by the **evaporation** of its solvent

Used on **porous materials**
Wood, paper, cloth are best



Hardenes in 5 – 10 min
Gains full strength in 24 hours



Clamp your pieces together



Most other adhesives do not adhere to PVA after it is cured

Common brands/names: **carpenter's glue**, **yellow glue** (aliphatic resin), school glue, Elmer's glue, Titebond III



Construction adhesive

Cures by the **evaporation** of its solvent

Begin to **harden quickly** and remain flexible when dry



Hardenes in 10 – 30 min
Gains full strength in 12 – 24 hours



No need to clamp



A thick mixture of natural or synthetic rubber dispersed in a solvent or water; the mixture varies depending on the application
e.g. Liquid Nails Heavy duty construction adhesive: mixture of acrylic adhesive, PVA, limestone, clay
e.g. Liquid Nails Polyurethane construction adhesive: mixture of polyurethane, limestone, quartz

Excellent for **filling spaces** between surfaces

Common brands: **Liquid Nails**



Hot glue

Cools to cure

Works on most materials, especially porous surfaces



Hardenes in 15 – 60 sec
Gains full strength in 24 hours



No need to clamp



No or low volatile organic compounds (VOCs) – harsh chemicals for the environment)

Good for **filling spaces** between surfaces

Provide **rigid-to-flexible** low-strength bonds.

They **melt when heated** and solidify when cooled

Require **special dispensing equipment** because they come in rods

Common brands: **Stanley, 3M**



Contact adhesive

Cures by the **evaporation** of its solvent



Hardenes in 5 – 30 min
Gains full strength in 24 hours



No need to clamp



Parts harden together instantly

Apply on both surfaces to be joined, air dry, and bring together; stick instantly and permanently. Made of a synthetic rubber (usually neoprene) dispersed in a solvent or water.

Adheres nicely to large surfaces such as plastic/wood laminate

“I want to adhere two different materials!”

Answer: Find the adhesive that is compatible with both of them

Example: I want to adhere wood to fabric – polyurethane, cyanoacrylate, PVA, contact adhesive, and construction adhesive adhere to wood and fabric. I choose one of these depending on my needs.



Want more specific advice?
Visit This-To-That

Pro Tips

Check the label before you do anything
to make sure it works on your materials in your environment - each adhesive has different variations.

Do you need to use an adhesive?
Would a mechanical fastener like a nail or bolt work better?

Work quickly.
Have all your pieces ready to be adhered before you open the adhesive package/bottle.

Clean all surfaces
before you adhere them to ensure the strongest bond.

Sand metal
and then wipe it clean! Microscopic rust will weaken the bond.

Use in well-ventilated areas.
Don't ever inhale adhesive fumes.

Does your adhesive need to be clamped?

The industry evaluates adhesives based on two things:
shear strength and peel strength

Main types of non-reactive adhesives

Emulsion adhesive: adhesive + evaporative solvent → solvent evaporates and leaves the adhesive behind

The adhesive is dissolved in solvent (water, other chemicals), so as the solvent evaporates it leaves the adhesive behind.

Hot melt: the adhesive is melted and applied