

# INDUSTRIAL ADHESIVES IN PROSTHETIC AND ORTHOTIC CONSTRUCTION

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During the past year the VA Prosthetics Center has been investigating various types of adhesives, especially those adhesives useful in prosthetics or orthotics. The following table is designed to be used as a quick reference by the prosthetist or orthotist for joining most materials used in limb and brace shops. The table also gives the sources of supply, cost as of March 1959, and characteristics of the adhesive tested.

In the past, the adhesive most commonly used to join *wood* were animal flake or ground glues. Today for wood, Timbond, a polyvinyl acetate, and the polyesters and epoxy resins are best. For bonding rubber, leather, fabric, etc., rubber cements are used. Stabond, a hexane toluol, and neoprene based adhesives are excellent substitutes for the rubber cements.

Although the tabulation is not complete and our investigations were not exhaustive, we can recommend that these listed adhesives are generally stronger and, in most cases, easier to apply than adhesives used formerly.

It should be recognized that adhesives are not the panacea for all fastening or bonding problems. On the contrary, adhesive bonding has its limitations just as do other methods of fastening. From a structural standpoint, a sandwich construction using adhesives as a bonding agent offers a number of advantages over riveting. For example, B/K joints can be sandwiched in a plastic B/K prosthesis shank by utilizing polyester or epoxy resins with such fillers as Solka-Floc (wood flour) or any fibrous filler. Local stress concentrations experienced around rivet holes on such joint attachments are eliminated by the relatively uniform distribution of the shear loads over the entire adhesive contact area.

The polyester and/or epoxy resin filled adhesives are being used routinely by the Limb and Brace Section, VAPC, as an adhesive to bond wood to wood, wood to metal, plastic to wood, and also for joining urethane foams to various other structural materials. However, the use of adhesives in metal to metal joining over small contact areas has not shown satisfactory results to date. A few metal to metal adhesives can be used for bonds that are subject to very low loads.

Further studies are continuing in the Testing and Development Laboratory of the VAPC to determine if adhesives can be applied more generally to replace some riveting, soldering, or welding. Interest is centered on developing adhesives that will provide metal to metal joints that will withstand high shear loads, have high peel and impact strength as well as satisfactory fatigue resistance. See table, pages 52-53.

Adhesive	Address & Source of Supply	Cost as of March 1959	Application
1. Epon VI	Shell Chemical Company New York, New York	2 lb. container \$4.50 per lb.	Spread thin coat w/ spatula or tongue depressor.
2. Bakelite C8 (ERL-2774)	Bakelite Company Div. of Union Carbide Corp. 30 East 42nd Street New York 17, New York	\$1.41 per lb. (Resin) (\$1.58 per lb. (Hardener)	Spread thin coat w/ spatula or tongue depressor.
3. Bakelite C8 (ERL-2795)	Bakelite Company Div. of Union Carbide Corp. 30 East 42nd Street New York 17, New York	\$1.41 per lb. (Resin) \$1.58 per lb. (Hardener)	Spread thin coat w/ spatula or tongue depressor.
4. Bondmaster M620	Rubber & Asbestos Corp. 225 Belleville Avenue Bloomfield, N. J.	1 gal. (8 lbs.) \$20.00	Spread thin coat w/ spatula or a tongue depressor.
5. Bond Cement 1524A—1 part 1525B—2 parts	Bond Adhesive Company Box 406 Main P.O. Jersey City 3, N. J.	$\frac{3}{4}$ oz. tube \$1.00—1525B $\frac{3}{4}$ oz. tube .75 1524A	Spread thin coat w/ spatula or a tongue depressor.
6. Laminac 4110	American Cyanamid Co. 30 Rockefeller Plaza New York 20, N. Y.	\$9.72 per gal.	Spread thin coat w/ spatula or tongue depressor.
7. Resin Solution T-24-9	Bakelite Company 30 East 42nd Street New York 17, New York	\$2.50 per gal.	Spread thin coat w/ spatula or tongue depressor.
8. Eastman 910	Armstrong Cork Co. Industrial Adhesive Sales Lancaster, Pa.	\$10.00 per (1) ounce	Spread thin by drops from a polyethylene bottle w/dispersing spout.
9. Timbond 600-5	Armour & Company Adhesives Division Meta-Lane Lodi, New Jersey	.54 per lb.	Apply a thin coat w/ brush or spatula.
10. Stabond T-161	American Latex Prod. Corp. 3341 West ElSegundo Blvd. Hawthorne, Calif.	\$7.90 per gal.	Apply a thin coat w/ brush or spatula.
11. Pliobond 30	The Goodyear Tire & Rubber Co. Akron, Ohio	8 oz. container \$1.10	Apply a thin coat w/ brush.
12. Barge (All purpose cement)	Barge Cement Co. 100 Jacksonville Rd. Towaco, New Jersey	\$1.34 per qt.	Apply a thin coat w/ brush.
13. Cat's Paw (Super Speed)	Cat's Paw Rubber Co., Inc. Baltimore, Maryland	\$1.80 per gal.	Apply a thin coat w/ brush.
14. Adrub #3214	Adhesives Products Corp. 1660 Boone Avenue Bronx 60, New York	\$1.25 per gal.	Spread thin coat w/ brush.
15. 3-Ton Adhesive	H. A. Calahan, Inc. 854 Mamaroneck Ave. Mamaroneck	\$3.96 for 8 oz.	Apply a thin coat w/ small brush or spatula.

Cure Time	How Cured	Base	Components	T&DL Observed Use
165°F—2 hrs. 200°F—45 min.	Contact pressure, and oven cure	Epoxy	2 parts paste	Metal to metal and all combinations wood, plastic glass, rubber, etc.
1) 5 hrs. room temp. 2) 30 to 40 min. at 300°F.	1) Air Cure 2) Oven	Epoxy	2 parts liquid	Metal to metal & bonding other rigid materials such as plastic, wood, etc.
1) 5 hrs. at room temp. 2) 300°F for 30 to 40 min.	1) Air Cure 2) Oven Cure	Epoxy	2 parts liquid	Metal to metal & other rigid materials such as plastic, wood, etc.
535°F 7 to 10 min. 500°F 12 to 15 min. 450°F 20 to 25 min. 400°F 40 to 50 min. 350°F 1½ hrs to 2 hrs. 300°F 4 hrs. to 5 hrs. 260°F 20 to 24 hrs.	Oven or hot press	Epoxy resin w/ aluminum filler	1 part paste	Metal, plastic, reinforced laminates & glass combinations.
24 hours. Full strength a few days.	Air Cured	Epoxy	2 parts liquid	Metal, glass, wood phenolic (hard) leather, fabrics and paper combinations.
Approx. 30 min. (full cure 5 to 7 hrs.)	Air Cured	Polyester	2 parts liquid 1 part paste	Metal to metal & bonding other rigid materials such as plastic, wood, etc.
Four seconds at 500°F to a few minutes at 300°F.	Oven and Pressure	Vinyl alcohol acetate resin	1 part liquid	Metal to metal
10 seconds to 8 minutes. For ultimate bond tensile strength: 48 hrs. ambient temp.	Air Cured	Cyanoacrylate Monomer	1 part liquid	Steel, aluminum, wood, glass, & neoprene combinations.
(3 to 7½ min.) gives max. strength on most woods.	Apply 20 to 35 PSI (Air Cure)	Polyvinyl Acetate Emulsion	1 part liquid	Wood to wood.
20 to 30 minutes.	Air Cured	Hexane Toluol & Ketones	1 part liquid	Neoprene, wood & belata belting combinations
1) Approx. 5 min. 2) Approx. ½ to 1 hr. 3) 20 min. at 225°F or 5 min. at 325°F.	1-Coat & wait until tacky, join & let dry, 2-Coat both surfaces & let dry. Next wet one or both surfaces w/MEK then join, press & let dry. 3-Coat both surfaces, after drying join them Hot press or oven w/ clamps.	Synthetic Rubber (BUNA) Butadiene-Styrene.	1 part liquid	Metal to metal & all combinations, rubber to plastic, wood to metal, fabrics to glass, ceramics to plastics, leather to paper.
20 to 30 minutes.	Air Cure	Neoprene Base	1 part liquid	Leather to leather, cork, rubber, glass, metal and wood combinations.
2 to 5 minutes.	Air Cured	Rubber	1 part liquid	Leather, rubber, cork combinations.
5 to 10 minutes.	Air Cured	Natural Rubber	1 part liquid	Leather, cork and rubber combination
Approx. 5 min. at 70°F.	Air Cured	(Not Known)	1 part paste 1 part liquid	Steel, aluminum, wood combinations.