

Fabrication

#1 Polymerizable Cement

Proper cementing of acrylic sheet is a vital step in manufacturing museum quality displays. When exhibiting valuable works of art, ACRYLITE acrylic sheet helps make the display case as perfect as the artwork. This tech brief gives advice to achieve excellent joints.

The following information is given regarding the use of chemically reactive, two-part polymerizable cements such as ACRIFIX® 2R0190.

Two-Component Adhesives

The cure is brought about by a chemical reaction.

Polymerizing adhesives are polymers dissolved in monomers which cure when a hardener is added.

Polymerizing adhesives fill better and, therefore, impose fewer demands on the accuracy of fit between the parts. They must be used where high strength and good resistance to environmental conditions are required.

Other two-component adhesives like epoxy resins, isocyanates (polyurethane), phenolics and aminoplastics are not suitable for bonding ACRYLITE sheet to itself or other materials because their adhesion is very low.

Workshop & Equipment

The following equipment is desirable when cementing facilities are being considered for polymerizable adhesives:

1. Flat Working Surface

Cover work area with glass or polyester film. Vapor removal is necessary. Solvent vapors are heavier than air.

2. Weighing Scale

The scale must have an accuracy of about one gram for weighing out the adhesive.

3. Mixing Vessels

Use round beakers made of glass, polyethylene or other materials which are insoluble and do not swell.

4. Stirrer

Stir small amounts with glass or polyethylene insoluble rods.

5. Vacuum Chamber

A small metal, glass or plastic chamber which can hold a beaker of the adhesive and is capable of withstanding a vacuum of 3 psi.

6. Vacuum Pump

A small vacuum pump capable of evacuating the above chamber to a vacuum of 3 psi.

7. Syringes

Disposable syringes for applying the adhesive.

8. Jigs & Fixtures

For mass production, it is advisable to use gluing jigs which can be used repeatedly. Parts can be attached with clips, clamps, lead weights or vacuum.

9. Sealing & Spacing

Use polyester tape to contain the adhesive.

Area Bonds

Area bonds may be produced either horizontally or vertically. Thin sheets and thick blocks can both be bonded in the horizontal position. Blocks can be bonded vertically.

For horizontal bonding, the degassed cement (bubble free) is poured on the panel approximately one-third the distance on the side as shown in Figure 1A. The adhesive may be held on the base with adhesive polyester tape. Any bubbles formed when the adhesive is poured should be removed.

Area bonding with a polymerizing adhesive—bonded sheet surfaces in a horizontal position

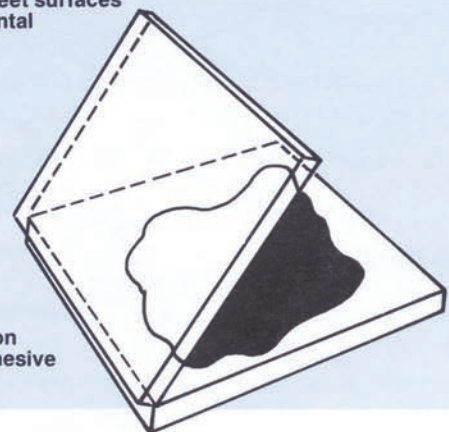


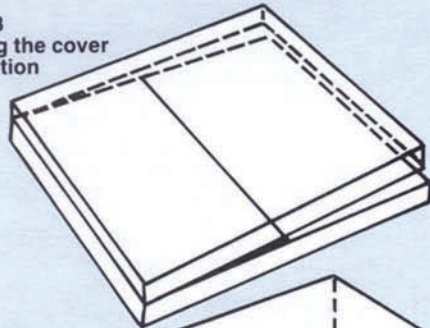
Fig. 1A
Application
of the adhesive

Starting from one edge, the top plate is placed in such a way that the adhesive moves evenly between the plates.

With thin sheets, the relatively high viscosity of the adhesive itself is sufficient to prevent the cement from being squeezed out from the area being bonded through the weight of the cover.

Thick blocks should be placed about .050 inches

Fig. 1B
Placing the cover
in position



Heavy cover

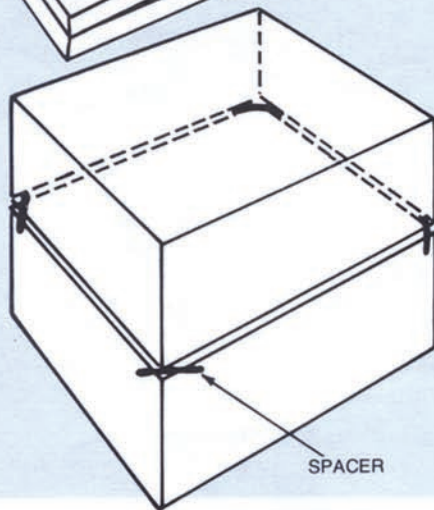
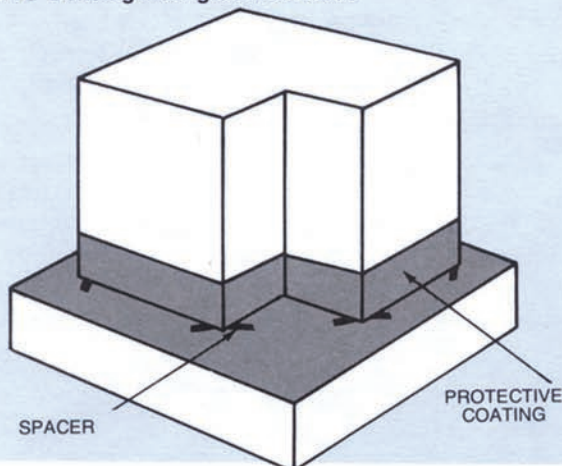


Fig. 1C Bonding incongruent surfaces

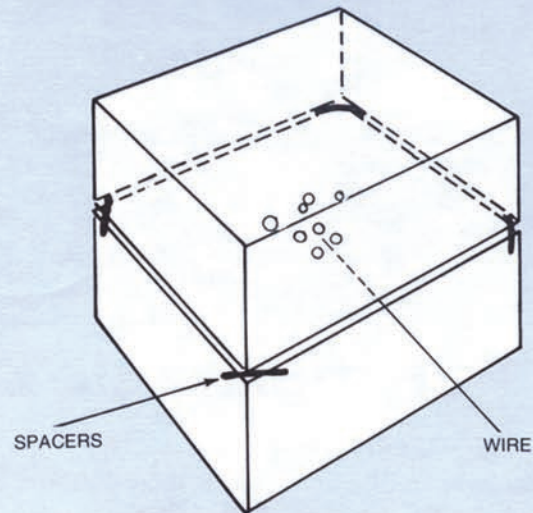


from the base by suitable spacers (polyethylene cords) as shown in Figures 1B and 1C.

If bubbles form while the cement is applied, they can be sucked out with fine capillaries as long as the adhesive is still soft. Bubbles can also be extracted by pricking them with a fine steel wire and then pulling them out at high speed. This technique, as shown in Figure 2, is most suitable when bonding large areas.

When areas are vertical, they are bonded by

Fig. 2 Removal of enclosed air bubbles from an area bond.



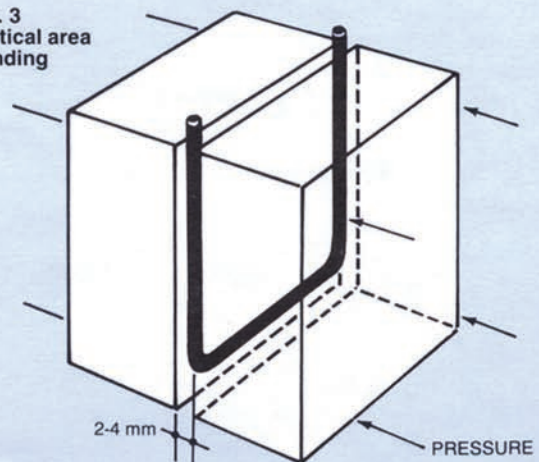
spacing the sheets or blocks with a soft elastic cord so as to provide a chamber at the top. The prepared adhesive is then poured into the chamber.

The minimum thickness of the chamber is .060 to .080 inches which allows the cement to flow without bubbles.

Bonding vertically has the following advantages.

1. An adhesive with bubbles can still be poured because the bubbles will rise to the top.
2. Since the adhesive area is thicker, blocks with variations in the thickness can be bonded.
3. Placement of the top plate, difficult in the horizontal method, is eliminated.
4. Adjoining surfaces may be covered with adhesive polyester film. When the cement starts to set (still just soft), remove the polyester film with any remaining cement. This is shown in Figure 3.

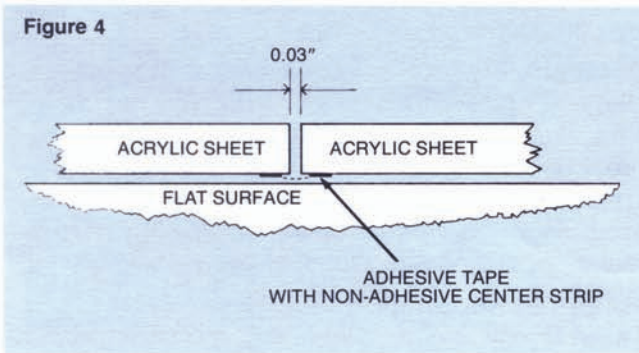
Fig. 3
Vertical area
bonding



Butt Joints

To create butt joints, the panels are fixed to a flat support, leaving a gap between them of at least .03 inches. The underside and faces of the gap are

sealed with adhesive tape with a non-adhesive center strip. See Figure 4.



The adhesive is introduced into the one open side of this joint by using a suitable syringe. Avoid bubbles.

The shape of the bonding gap depends primarily on the thickness of the panels that will be butt-joined. When the tensile stress is to be uniaxial, V-butt joints with a 60° aperture angle provide the highest tensile strength as shown in Table 1. However, aperture angles of this size are only practical when the sheets are thin.

TABLE 1

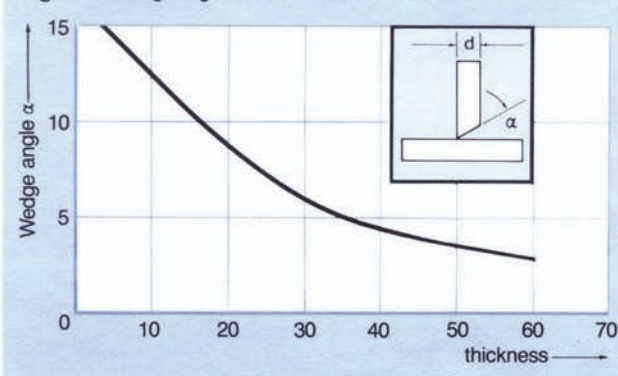
Sheet thickness (inches)	Aperture angle of the seam	Minimum thickness of the glue line (inches)
Approx .220"	butt joint with single V groove - 30°	.03"
Approx 1.25"	butt joint with single V groove - 15°	.03"-.06"

The shrinkage of the adhesive during polymerization and heat conditioning is about 15-20% by volume. Therefore, to prevent a concave surface, the gap should be sufficiently over-filled with adhesive.

T-Joints

Bonding must be done in suitable jigs to ensure that the bonding materials are fixed during bonding and the cure.

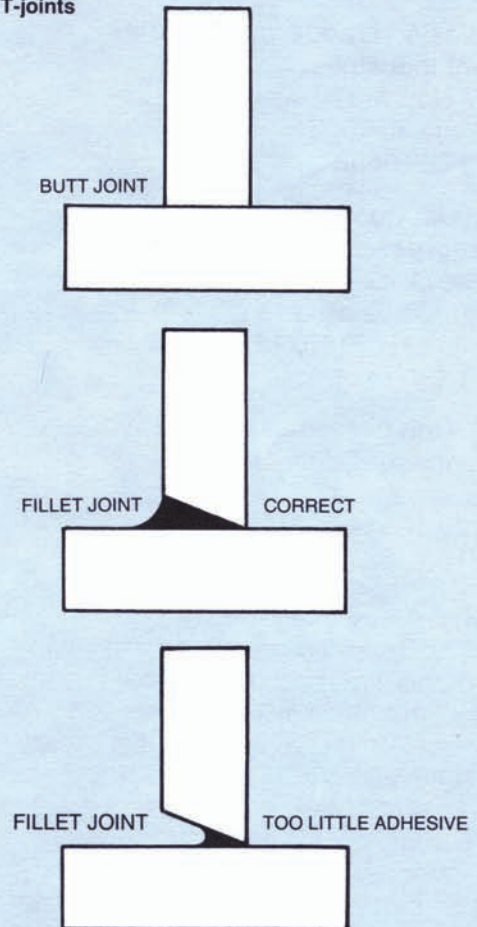
Figure 5 Wedge angle α as a function of the material thickness d



When creating T-joints, spacing the bonding gap uniformly is difficult, especially when the adhesive joints of thin materials are long. In addition, there is an adhesive bead on either side of the joint. Solvent cements are better for bonding thin sheets with a blunt edge. A beveled edge is generally useful for polymerizing adhesives because it allows one sheet's edge to be placed directly on top of the other. In practical trials the relationship between the wedge angle and the material thickness, as shown in Figure 5, has given best results.

In order to produce an adhesive bead, the horizontal sheet should project as shown in Figure 6.

Figure 6 T-joints



Finishing the Adhesive Joint

A bonded part should be heat conditioned (annealed) before finishing the adhesive joint. If not, it could form constrictions when it is later heat conditioned and the constrictions would impair the bond strength.

Concave grooves are planed with a router mounted on a sliding carriage.

When higher demands are imposed on the optical quality of the bond, the finished surfaces may be additionally sanded with fine, wet, abrasive paper or fine steel wool and then polished.

To keep the work of finishing to a minimum, the amount of adhesive in the joint is best kept low so that only a little of it projects after heat conditioning.

Sources of Supplies

Tape-Solvent Resistant

Scotch Brand #685 Riveters Tape

3M Company

3M Center
St. Paul, MN 55144
(612) 733-1441

Applicators

Nozzled Bottles-Plasticator

Craftics Inc.

2701 No Pulaski Road
Chicago, IL 60639
(312) 235-3307

Bottles & Hypodermic Needles

Gaunt Industries

6217 Northwest Highway
Chicago, IL 60631
(312) 774-5658

Vacuum Pump

(Compressed Air to Vacuum)

Vortec Corporation

10125 Carver Road
Cincinnati, OH 45242
(513) 891-7474

Piab Unit

Sprague Air Controls Inc.

65 Sharp Street
Hingham, MA 02043
(617) 337-6200

Flammability

ACRYLITE acrylic sheet is a combustible thermoplastic. Precautions should be taken to protect this material from flames and high heat sources. ACRYLITE acrylic sheet usually burns rapidly to completion if not extinguished. The products of combustion, if sufficient air is present, are carbon dioxide and water. However, in many fires sufficient air will not be available and toxic carbon monoxide will be formed, as it will from other common combustible materials. We urge good judgement in the use of these versatile materials and recommend that building codes be followed carefully to assure they are used properly.

The following combustibility data is applicable to ACRYLITE GP acrylic sheet: self-ignition temperature (ASTM D-1929) is 910°F (for .60" thickness), smoke density (ASTM D-2843) is 10.3%, rate of burning of 2mm thickness (ASTM D-635) is 4.6cm per minute.

While these data are based on small scale laboratory tests frequently referenced in various building codes, these tests do not duplicate actual fire conditions.

Compatibility

Like other plastic materials, ACRYLITE sheet is subject to crazing, cracking, or discoloration if brought into contact with incompatible materials. These materials may include cleaners, polishes, adhesives, sealants, gasketing or packaging materials, cutting emulsions, etc.

Important Information

The information and statements herein are believed to be reliable but are not to be construed as a warranty or representation for which we assume legal responsibility. Users should undertake sufficient verification and testing to determine the suitability for their own particular purpose of any information or products referred to herein. NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS MADE. Nothing herein is to be taken as permission, inducement or recommendation to practice any patented invention without a license.

For additional information contact:

Evonik Degussa Corporation

CYRO Industries

379 Interpace Parkway

PO Box 677

Parsippany, NJ 07054

800-631-5384

www.cyro.com

www.evonik.com

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