

Surface Preparation and Pretreatment of Structural Adhesives

-Ciba Adhesives

**Working directions for the
surface preparation essentials
for optimum adhesion between
structural materials with**

Araldite® Adhesives

Epoxy resin adhesion to metals, plastics, etc.

Araldite resins adhere firmly to most materials. Bonds of great strength are obtained after removal of grease and loose surface deposits, e.g. rust, from the surfaces to be joined, but when maximum strength is required a more thorough mechanical or a chemical pretreatment is recommended.

Surfaces are prepared by one of the following pretreatment procedures (listed in order of increasing effectiveness):

1. **Degrease only.**
2. **Degrease, abrade, and degrease again.**
3. **Degrease and chemically pretreat.**

Care must be taken to avoid contaminating the pretreated surfaces prior to bonding. Contamination may be caused by finger marking - or by cloths which are not perfectly clean - or by sub-standard degreasing or chemical solutions.

Whatever the pretreatment procedure used, it is good practice to bond the surfaces as soon as possible after completion of the pretreatment i.e. when surface properties are at their best.

Bonding the materials for which pretreatments are given in this manual comprises the main part of high-strength adhesive work. Materials less commonly used and not specifically dealt with in this manual may require only simple degreasing and abrading (as described below) but if other pretreatments appear necessary advice should be obtained from CIBA.

Degreasing

The removal of all traces of oil and grease from the surfaces to be bonded is essential. Degreasing by one of the three methods given below should be carried out even when the surfaces to be bonded appear clean. Remove all traces of oil and grease as follows: Suspend in trichloroethylene or perchloroethylene vapour. Or where a vapour degreasing unit is not available: Wipe the joint surfaces with a clean cloth soaked in clean trichloroethylene. Allow to stand for a minute or two to permit complete evaporation from the joint surfaces. Note This solvent is toxic both in liquid and vapour form. The place of work must be well ventilated and no smoking should be allowed while vapour is present. Or scrub the joint surfaces in a solution of detergent or, for metals only, immerse or spray in a suitable alkaline degreasing agent. Wash with clean hot water and allow to dry thoroughly - preferably in a stream of hot air, e.g., from a domestic hair-dryer. Ultrasonic degreasing has been found to give excellent results when pretreating very small components. Trichloroethylene, acetone, methylene chloride, tetrachloroethylene, etc. are good degreasing agents. Alcohol, gasoline and paint thinners are not. Stabilized 1, 1, 1-trichloroethane is an excellent degreasing agent of low toxicity and flammability. ***To find out whether a surface has been properly degreased, drip distilled water onto it. If the water forms a film, the surface is free from grease. If it forms drops, the surface will have to be degreased again. Note: Not reliable on anodized light alloys as water will sometimes form a film on their surfaces even though not properly degreased.***

Abrading

Lightly abraded surfaces give a better key to adhesives than do highly polished surfaces. Properly abraded surfaces show no smooth, polished areas.

Abrasion treatment should always be followed by a second degreasing treatment. This will also ensure the removal of loose particles.

Metal surfaces are freed from surface deposits, e.g. tarnish, rust or mill scale, by grit-blasting. If grit-blasting equipment is not available or the metal is too thin to withstand blast treatment, clean the joint surfaces with a wire brush, emery cloth or glass-paper. (Use grade 80-150 abrasives for steel and materials resistant to scoring, but grade 300-600 abrasives for light alloys and less resistant materials.)

Painted surfaces should normally be stripped with a proprietary stripper prior to preparation, otherwise the strength of the joint may be limited by the comparatively low adhesion of paint to metal.

Chemical pretreatment

The surface preparation described above, i.e. degreasing alone or degreasing followed by abrasion and further degreasing, is sufficient for most adhesive work.

But to obtain maximum strength, reproducibility and resistance to deterioration, a chemical or electrolytic pretreatment is required.

Care must be taken in the preparation of the chemical solution, not only because of the materials involved, but also because incorrect proportioning may lead to bond strengths inferior to those that would have been obtained if there had been no chemical pretreatment whatsoever.

Time of application is also critical: too short an application does not sufficiently activate the surfaces, whereas overlong application builds up a layer of chemical reaction products which may interfere with adhesion.

Acrylic glass (Plexiglas®, Perspex®, Resartglas®, etc.). Degrease with detergent solution. Roughen with emery cloth or by grit-blasting, and remove all dust particles with a dry-air blast or a non-clouding solvent such as methanol.

Aluminium and aluminium alloys

Degrease. Abrade with emery cloth or by grit-blasting, and degrease again.

Alternatively, degrease and etch in a chromic acid + sulphuric acid solution* made up as follows:

Pour 10-15 litres of clean water into a container with a 50 litre calibration mark. While stirring the water, add 7.55 litres of concentrated sulphuric acid (s.g. 1.82) in a slow steady stream - with continued stirring add 2.5 kg of dry chromic acid (CrO₃) - or 3.75 kg of sodium bichromate (Na₂Cr₂O₇+H₂O) - and fill to the 50 litre calibration mark with clean cold water.

Immerse the part for 30 minutes at 60-65C, then wash with clean cold running water, followed by clean hot water, and dry with hot air. The temperature of the hot water and air must not be greater than 65 C.

(4.5 litres of etching solution suffice for about 20 square metres of aluminium surface.)

Aluminium, anodized

Degrease thoroughly. Adhesion of the Araldite will depend on the thickness and structure of the oxide layer as well as on the type of pore sealer used. For bonds of maximum strength, it may often be necessary to abrade or etch the surfaces to be bonded.

Asbestos board

Degrease. Abrade, remove dust and degrease. Allow the board to stand a few minutes to ensure that all the degreasing agent evaporates out.

Brass

Degrease. Abrade with emery cloth or grit-blast, and degrease again.

Cadmium

Degrease. Abrade with emery cloth or grit-blast, and degrease. Apply the adhesive as soon as possible after pretreatment.

Cast iron

Degrease. Grit-blast or abrade with emery cloth, and degrease again. Degrease grey cast iron until it no longer soils a white rag.

Ceramics, porcelain

Smooth surfaces: Degrease. Abrade with carborundum + water slurry, dry and degrease.

Glazed surfaces: Remove glaze by grit-blasting or with emery cloth, and degrease.

Earthenware: Dry thoroughly, clean with wire brush, and remove all loose particles.

Chromium

Degrease. Abrade by grit-blasting or with emery cloth, and degrease again.

*This procedure conforms to Ministry of Technology. Specification DTD 915B. A procedure for controlling the composition of etch solution in continual use is included in the Specification.

Concrete

Remove heavy grime and laitence by wire-brushing. Degrease with a proprietary detergent solution. Where concrete is deteriorated and weak, the surface must be removed until sound concrete is exposed. Even where concrete is sound, it should be pretreated wherever practicable by one of the following methods. Method 1 is more effective than 2, and 2 is more effective than 3.

1. Remove by mechanical scarification 3 mm (1/8 inch) - or more -of all surfaces to be bonded, then remove dust, preferably by vacuum-cleaner.

Or

2. Sand-blast about 1.5 mm (1/16 inch) off all surfaces to be bonded, then remove dust, preferably by vacuum-cleaner.

Or

3. Etch with 15% hydrochloric acid solution* (1 litre per square metre, spread by stiff-bristle brooms) until bubbling subsides (about 15 minutes). Wash with clean water by high-pressure hose until all slush is removed and the surface is neutral to litmus. Final rinsing with 1% ammonia solution followed by clean water is good practice - this ensures thorough neutralization. Allow the surface to dry thoroughly. Remove dust, preferably by vacuum-cleaner.

Copper and copper alloys (excluding brass)

Degrease. Abrade by grit-blasting or with emery cloth and degrease. Or etch in a solution of:

Ferric chloride (FeCl ₃ +6 H ₂ O) 42% solution	3.75 litres
Concentrated nitric acid (s.g. 1.42)*	7.5 litres
Water	50.0 litres

Immerse for 1-2 minutes at room temperature, wash with plenty of clean cold water and dry promptly with a room temperature aluminium and aluminium alloys Degrease. Abrade with emery cloth or by grit-blasting, and degrease again.

Alternatively, degrease and etch in a chromic acid + sulphuric acid solution* made up as follows: Pour 10-15 litres of clean water into a container with a 50 litre calibration mark. While stirring the water, add 7.55 litres of concentrated sulphuric acid (s.g. 1.82) in a slow steady stream - with continued stirring add 2.5 kg of dry chromic acid (CrO₃) - or 3.75 kg of sodium bichromate (Na₂Cr₂O₇+H₂O) - and fill to the 50 litre calibration mark with clean cold water. Immerse the part for 30 minutes at 60-65°C, then wash with clean cold running water, followed by clean hot water, and dry with hot air. The temperature of the hot water and air must not be greater than 65C.

(4.5 litres of etching solution suffice for about 20 square metres of aluminium surface.)

Foam plastics - polystyrene

Sand down lightly if soiled and remove all particles and dust. Do not clean with solvents.

Foam plastics - rigid PVC, polyurethane

Sand down lightly to remove any residual release agent or soil. Remove all particles and dust.

Galvanized steel

Abrade with emery cloth and degrease.

Alternatively, degrease and etch in a solution of:

Concentrated hydrochloric acid* 15 parts by volume

Water 85 parts by volume

Immerse for 2-4 minutes at room temperature, wash with clean hot water, followed by clean cold water, and dry thoroughly in an oven at 60-70C or with hot air.

Better still, pretreat with Parcodine 120** as recommended by manufacturers.

Bond galvanized steel immediately after pretreatment has been completed.

Glass and silica

Degrease thoroughly. Better still, grit-blast until matt or abrade with carborundum + water slurry, dry and degrease.

Then either heat for 30 minutes at 100C and apply the adhesive before the glass cools to room temperature, or apply a silane primer at room temperature (e.g. 2% Silan A 186*** in acetone).

Glassfabric laminates epoxy/glass

Degrease, abrade with emery cloth or steel wool, and degrease again.

Polyester/glass

Degrease, abrade down to the glass with emery cloth, degrease with a proprietary aqueous detergent, and dry.

Graphite and carbon

Degrease. Abrade with fine emery cloth and degrease.

Make sure all traces of solvent have evaporated before applying the adhesive.

Lead, tin, solder

Degrease. Abrade lead with emery cloth or fine steel wool, then degrease until it no longer soils a white rag.

Degrease and lightly abrade tin, solder and tin-plated metal, then degrease again.

Leather

Degrease. Roughen with glass-paper and degrease again.

Magnesium and magnesium alloys

Degrease. Abrade with emery cloth, degrease, and apply the adhesive immediately.

*Caution: Handle with care

**Parcodine 120 is available from: Soci6t6 Continentale PARKER, 40-42, rue Chance-Milly, Clichy (Seine) France; Meta l loasalschaft AG. T.A. Bonder. Frankfurt/Main. Federal ReDublic of Germanv; Sotec AG, 8700 Kusnacht (ZH), Switzerland.

*** Union Carbide Europe SA, Geneva

Alternatively, immerse for 5 minutes at 70-75C in a solution of:

Caustic soda* 6.2 kg
Water 50.0 litres

wash with clean running water, then etch in a solution of:

Chromic acid (CrO₃)* 5.0 kg
Water 50.0 litres
Sodium sulphate (anhydrous) 0.031 kg

Wash with cold water, followed by clean hot water, dry with hot air and apply the adhesive immediately.

Nickel

Degrease. Abrade with emery cloth or grit-blast, and degrease again.

Alternatively, etch for 5 seconds in concentrated nitric acid (s.g. 1.42).

Wash with clean cold water, followed by clean hot water, and dry with hot air.

Nylon (polyamide)

Degrease with detergent solution. Roughen by grit-blasting or with emery cloth (and degrease again).

Alternatively, for what are usually better results, prime with a mix of 100 g I&Redux K6 with 15 g para-toluene sulfonic acid dissolved in 85 g ethyl alcohol.

Plaster

Allow the surface to dry thoroughly. Smooth with fine emery cloth and remove dust.

Polyester resins

Degrease. Roughen with emery cloth or steel wool and degrease with a proprietary aqueous detergent, acetone, or methyl ethyl ketone.

Polyethylene and polypropylene

See 'Pretreatment of Plastics' on following pages

Precious metals

Degrease gold, silver and platinum. If this does not suffice, and if silver is tarnished (sulphides), abrade with fine emery cloth and degrease again.

Precious stones

Degrease.

PTFE (Teflon) See 'Pretreatment of Plastics' on following pages.

PVC, rigid Wipe with a clean cloth soaked in clean trichloroethylene. Roughen with emery cloth and degrease. See 'Pretreatment of Plastics' on following pages.

*Note: Use with Caution

Rubber

Thorough roughening and degreasing will sometimes suffice, but in most cases the following procedure will be necessary:

Treat the surfaces for 2-10 minutes with concentrated sulphuric acid, wash with clean cold water, followed by clean hot water, and dry. Flex the rubber - the appearance of minute hair-line cracks on the surface indicates that it is ready for bonding. (The time of treatment with the acid will depend on the grade of rubber.)

Vertical surfaces may be treated with a paste prepared by adding barytes powder to the concentrated sulphuric acid until it ceases to flow.

Rubber, synthetic

Treat with concentrated sulphuric acid as for natural rubber. (The time required may be longer.) If the surfaces feel very smooth or greasy, roughen them before treating with acid.

If minute surface cracks fail to appear on flexing, continue treatment using concentrated nitric acid until the cracks do appear. Wash with clean cold water, followed by clean hot water, and dry.

Silicone rubber and a few other synthetic rubbers cannot be bonded with Araldite adhesives.

Steel, stainless (chrome steel, chrome-nickel steel)

Degrease. Abrade with non-metallic abrasives (e.g. use emery cloth or grit-blast) and degrease.

To enhance the strength of bonded joints, etch the stainless steel in a solution of:

Oxalic acid*	14.0 kg
Concentrated sulphuric acid* (s.g. 1.82)	12.2 kg (6.7 l)
Water	70.0 litres

Immerse for 10 minutes at 85-90C, remove from the solution and, under clean cold running water, brush off the black deposit with a clean stiff brush.

Dry with hot air.

Bond as soon as possible after pretreatment has been completed.

Titanium

Degrease. Abrade with emery cloth or steel wool, and degrease again.

Alternatively, either degrease with trichloroethylene, abrade with a rotary steel brush and degrease again; or degrease with trichloroethylene, etch for 3 minutes at room temperature in hydrofluoric acid 15%*, wash off brownish deposit immediately, and dry.

Tungsten and tungsten carbide

Degrease. Abrade with emery cloth or grit-blast, and degrease.

Alternatively, either etch for 10 minutes at 80-90C in a solution of:

Caustic soda (sodium hydroxide)*	8.5 kg
Water	20.0 litres

wash with clean cold water, followed by clean hot water, and dry;

*CAUTION: Handle with Care

(Continued) or etch for 2-5 minutes at room temperature in a solution of:

Hydrofluoric acid*	25 grammes
Concentrated nitric acid*	150 grammes
Concentrated sulphuric acid*	250 grammes
Water	75 grammes

wash and dry in an oven at 65-80 C.

Wood

Smooth with glass-paper. Ensure the wood is dry (moisture content not higher than 8-12%).

Wood free of grease requires no pretreatment.

Wrought iron and mild steel

Degrease. Grit-blast or abrade with emery cloth, and degrease again.

Alternatively, etch in a solution of:

Orthophosphoric acid (88%)*	10 litres
Industrial methylated spirit	5 litres

Immerse for 10 minutes at 60C, remove from solution and, under cold clean running water, brush off the black deposit with a clean stiff brush. Dry in an oven or with hot air. Apply adhesive before rust can form.

Zinc and zinc alloys

Degrease. Abrade with emery cloth, degrease again, and apply the adhesive immediately.

Alternatively, etch like galvanized steel.

PRETREATMENT OF PLASTICS

Thermosetting plastics: Mouldings, castings, laminates, etc. can usually be bonded without difficulty. To ensure good bond strength, all soil and residual release agent must be removed from the joint surfaces before the Araldite adhesive is applied. The surfaces must either be abraded with emery cloth or grit-blasted, or they must be cleaned with a solvent such as acetone, methylethylketone, etc. Abrading or grit-blasting is recommended for mouldings since their surfaces may otherwise repel the adhesive.

Thermoplastics: These are often difficult to bond. Certain types permit only moderately successful bonding, and one and the same material may show considerable variation in properties determining the strength of a bond. Special adhesives have been developed, but they usually prove to be unserviceable when thermoplastics have to be bonded to materials such as wood, metal, etc. Araldite adhesives can be very useful in such cases even though their suitability for bonding thermoplastics is only limited. Pretreated thermoplastics for special applications (e.g. ski 'skins') are easily bonded with Araldite.

*Note: Use with Caution

Pretreatment of Plastics (Continued)

Pretreatment of plastics by the following methods has been found to give good to excellent bonds. However, since the grade of plastic and the manufacturing process used to make the component may affect the optimum application time of the chemical pretreatment, it would be advisable to establish by trial whether the specified time needs to be adjusted.

ABS-plastics
Polycarbonates (e.g. ®Makrolon) .
Polymethyl methacrylate (e.g. ®Perspex)
Polystyrene methanol.
Polyvinylchloride (rigid)

Abrade with emery cloth or grit-blast. Remove dust with methanol

Acetal resins (e.g.® Delrin, ®Hostaform C)
Diallylphthalate resin (e.g.® Dapon)
Epoxy resins
Urea resins .
Phenolic resins Degrease
Polyamides (e.g. Nylon, ®Ultramid etc.)
Polyester resins
Polyphenylene oxide
Polyurethanes

Abrade with emery cloth or grit-blast. Degrease with acetone and remove dust

Chlorinated polyethers (e.g. Penton)
Polyethylene
Polyformaldehyde
Polypropylene

Degrease with acetone and etch in a solution of:

Concentrated sulphuric acid (s.g. 1.82)	3.00 kg (1.65 litres)
Potassium dichromate	0.25 kg
Water	0.15 kg

Plastic	Immerse for	at degrees Centegrade
Chlorinated polyethers	about 5 min	70
Polyethylene	10-15 min	25
Polyformaldehyde	10-20 sec	25
Polyphenylene oxide	5-15 sec	70
Polypropylene	1- 2 min	70

After immersion, wash surfaces with clean cold water and dry carefully.
Alternatively, burn off the joint surfaces by moving them through a blue, not yellow, bunsen or acetylene flame until they appear smooth and polished.
Do not overheat or melt the plastic.

ABS plastics (acrylonitrile-butadiene-styrene)

Degrease with detergent solution and etch in solution of:

Concentrated sulphuric acid (s.g. 1.82)	14.0 litres
Potassium dichromate	0.2 kg
Water	5.0 litres

Immerse for 5-20 minutes at 20-60C, wash with clean cold water, followed by clean hot water, and dry with hot air.

Acetal resins (e.g. Delrin, Hostaform C, etc.)

Degrease and etch for about 20 seconds in a solution of:

Concentrated sulphuric acid (s.g. 1.82)	3.0 litres
Potassium dichromate	0.150 kg
Water	0.24 litres

wash with clean water and dry.

Alternatively, either degrease and etch for 5-10 seconds at 90 - 100C in a solution of:

Perchloroethylene	96.0 parts by weight
Dioxane	3.7 parts by weight
p-Toluene sulphonic acid	0.3 parts by weight

then heat in an oven for 30-60 seconds at 100-120C, wash thoroughly with hot water (about 60C), and dry; or burn off like polyethylene.

PTFE ('Teflon')

Degrease and etch in a solution made up as follows:

Pour 2 litres tetrahydrofuran into a three-necked flask fitted with a calcium chloride tube and a mixer. In it dissolve 256 grammes naphthalene, then add 46 grammes fragmented metallic sodium. The sodium will take about 2 hours to react with the naphthalene. The solution will then be brownish black in colour and ready for etching PTFE; it will keep for 2 to 3 months in a sealed container.

Immerse the PTFE surfaces for about 15 minutes at room temperature, then wash them with acetone, followed with clean running water, and dry thoroughly. The dry, etched PTFE will be brown in colour.

'Teflon' pretreated for bonding with Araldite is available in foil and sheet form from various firms. Names and addresses are available on request.

Various chemical pretreatments described above were copied from the following publications:

Charles V. Cagle,	Adhesive Bonding (McGraw-Hill Book Company, New York)
H. Lucke,	Kunststoffe und ihre Verklebungen (Verlag Brunke Carrels, Hamburg)
F. K. Trietsch:	Die Metaliverklebung (Deva Fachverlag, Stuttgart)

CAUTION....CAUTION....CAUTION

Solvents: Organic solvents must be handled with care since their use Caution raises a fire and/or toxic hazard. The appropriate handling precautions should be ascertained and strictly followed.

Acids and caustic soda:

Concentrated acids and hot caustic soda solution are aggressive chemicals. It is advisable to wear goggles and protective clothing when handling them. Never pour water into acids.

Always pour the acid slowly into the water, stirring all the while.

Araldite resins and hardeners: As with many other chemicals, some precautions must be taken when working with uncured epoxy resins and hardeners. For details, consult "Hygienic precautions for handling plastics products of CIBA-GEIGY" (Publication No. 24264/e).
A copy of this brochure will be supplied on request.