Advanced Materials

HUNTSMAN

Enriching lives through innovation

Araldite® industrial adhesives

Surface preparation and pretreatments

User's guide

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Araldite®

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Surface preparation and pretreatments

2-1 Introduction

General considerations

Working directions for the surface preparation are essential for optimum adhesion between structural materials bonded with Araldite® adhesives.

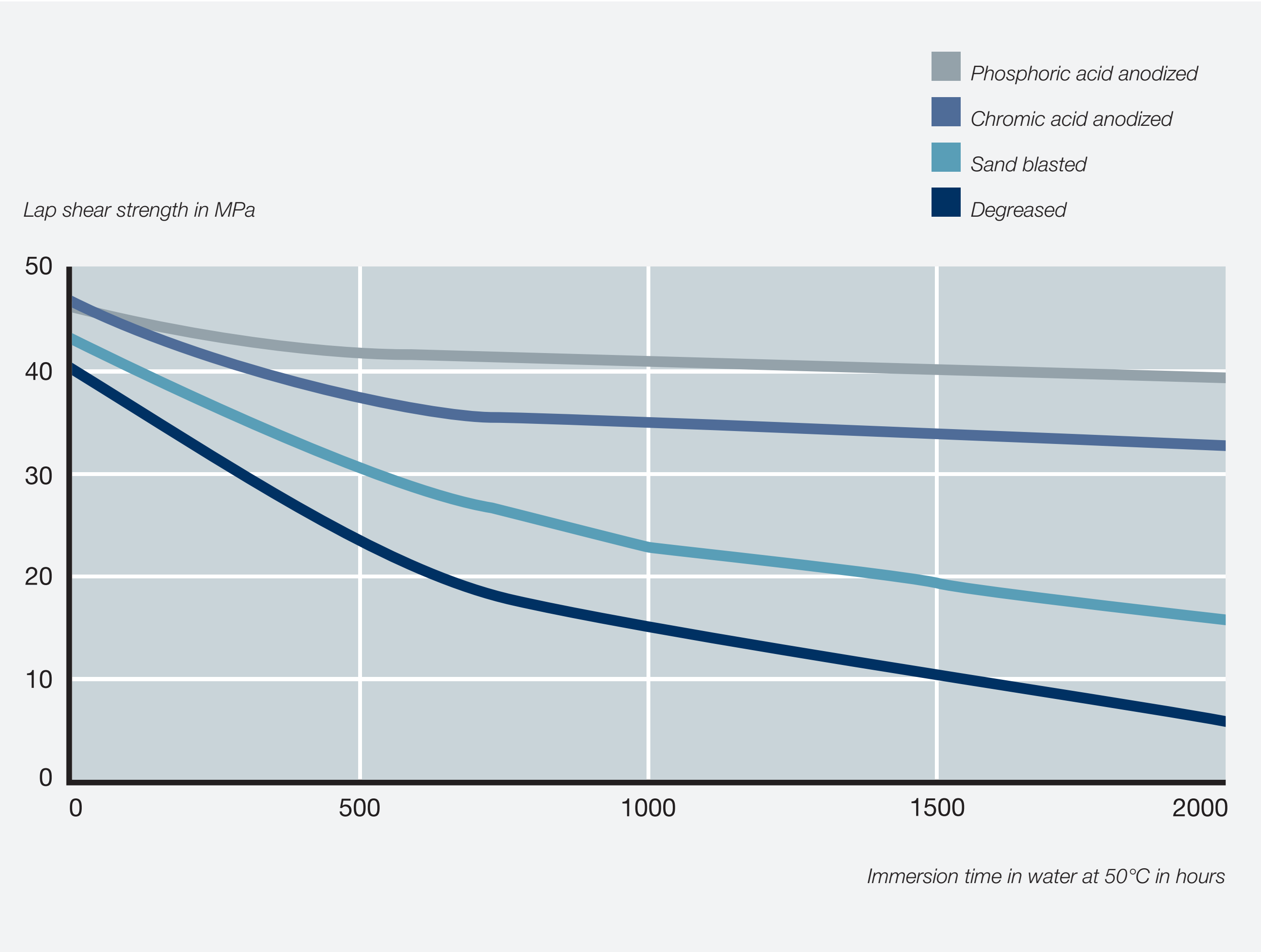
Bonding performances are always a combination of multiple factors, such as mechanical, chemical or electrostatic interactions. Bonding is a matter of interface, as the adhesive has to adhere well to the substrates to be bonded. Therefore, the surface conditions of the parts to be bonded are a critical factor in achieving a dependable quality bond.

Huntsman industrial adhesives are high performance adhesives which adhere firmly to most materials. High strength bonds can be obtained after removal of grease and loose particles, e.g. rust, from the surfaces to be joined. However, when maximum strength and long-term durability are required, a more thorough mechanical or a chemical surface pretreatment is highly recommended.

The type of surface preparation to be carried out prior to bonding depends on the expected performances (Figures 18, 19 and 20), the service conditions of the assembly and economic considerations (ratio costs / benefits).

Fig.18 Ageing behaviour in water of a bonded aluminium assembly

(with different surface preparations)



Surface preparation and pretreatments

2-1 Introduction

Fig.19 Performances of Araldite® adhesives on atmospheric plasma treated plastics: systematic substrate failure

(Araldite® 2015: 2K epoxy adhesive - Araldite® 2029: 2K polyurethane adhesive)

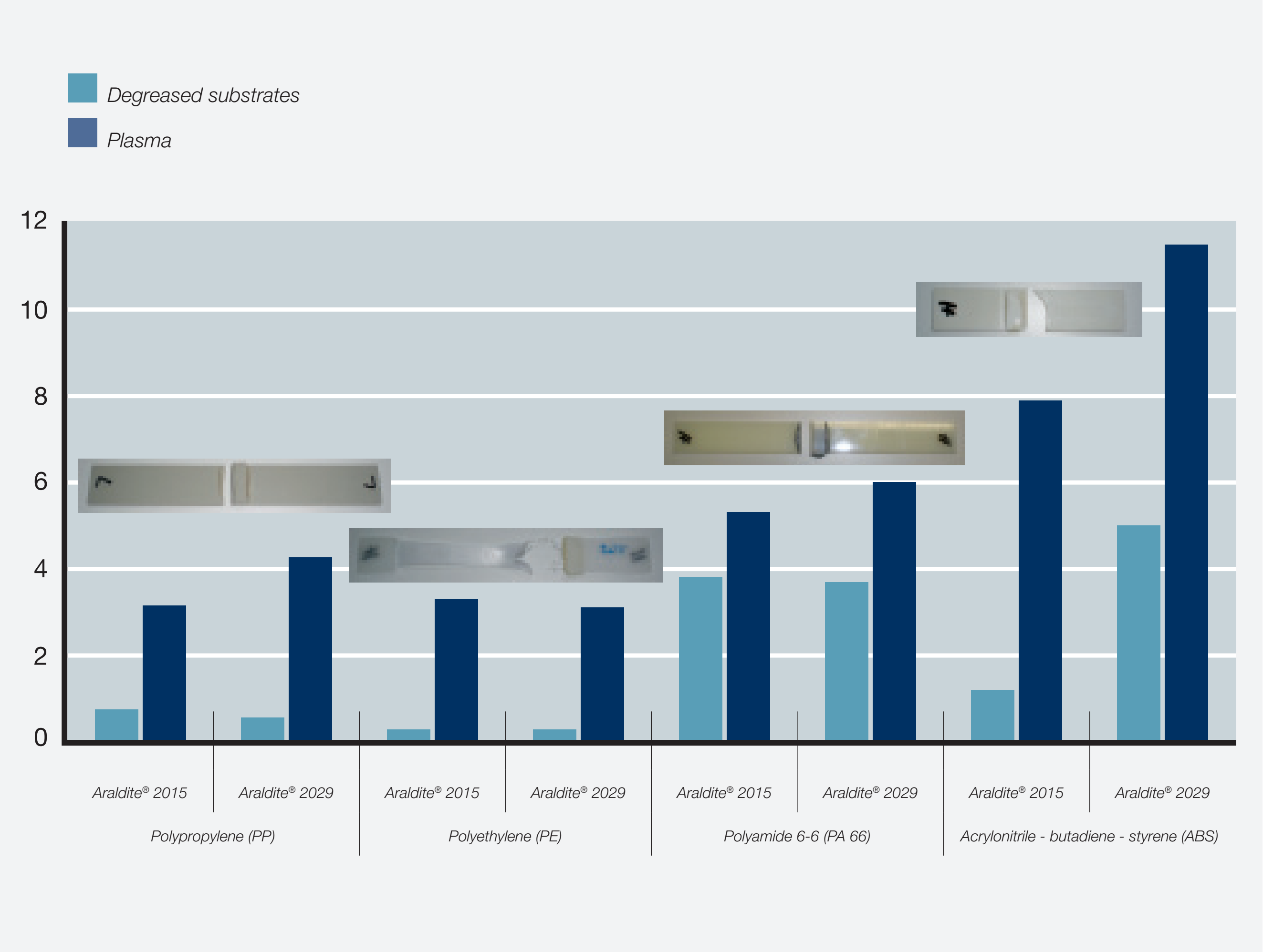
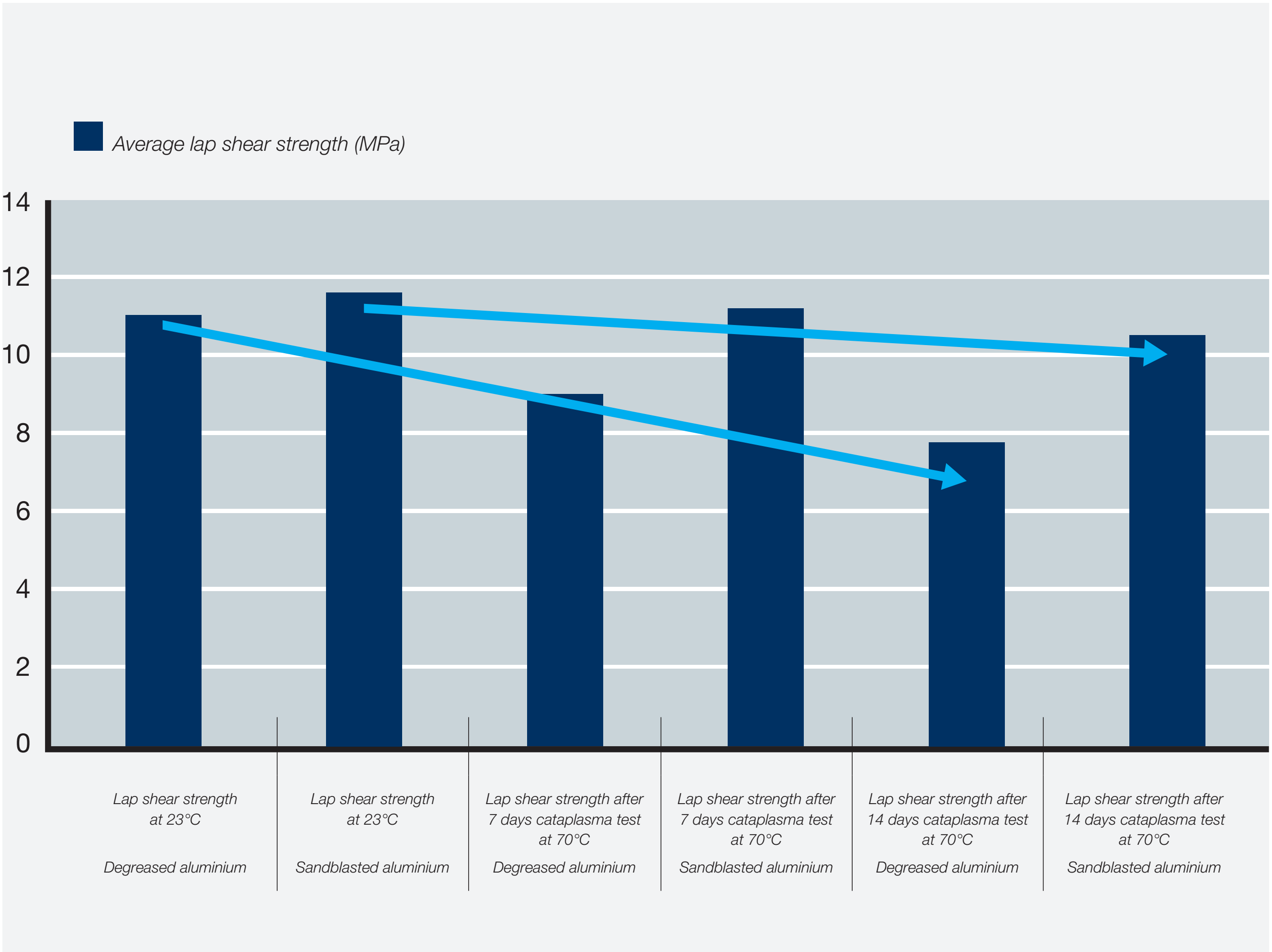


Fig.20 Ageing performances of Araldite® 2015 on aluminium with different surface preparations

(wet cataplasm ageing, degreased and sandblasted aluminium)



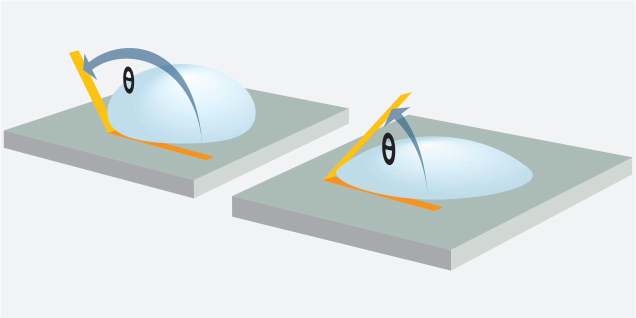
Surface preparation and pretreatments

2-1 Introduction

Why a surface preparation?

In order to ensure an optimum wetting of the substrate, a thorough surface preparation is required:

> To remove contaminants and / or low cohesion layers (oxides)
> To offer a clean surface for bonding
> To increase the bonding area
> To increase the surface energy of the substrate to be bonded (eg. by creating active sites on the surface)



Wetting angles before surface preparation (left) and after (right)

Care must be taken to avoid contaminating the surfaces during or after pretreatment. Wear clean gloves.

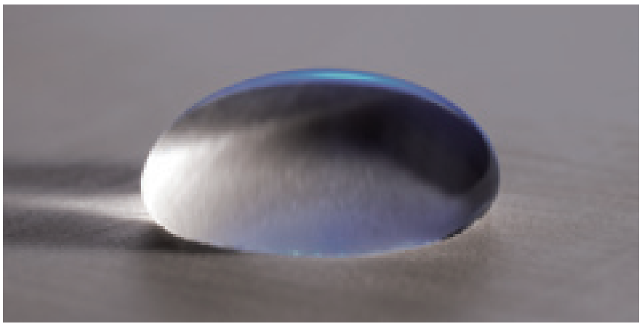
Contamination may be caused by finger prints, by using dirty cleaning rags, by oil contaminated abrasives, by substandard degreasing or chemical solutions. Contamination may also be caused by other work processes taking place in the bonding area. Particularly to be excluded are oil vapors from machinery, spraying operations (paint, mold release-agent, etc.) and processes involving powdered materials.

Whatever the pretreatment procedure used, it is always a good practice to bond the surfaces immediately after the pretreatment has been performed i.e. when surface properties are at their best.

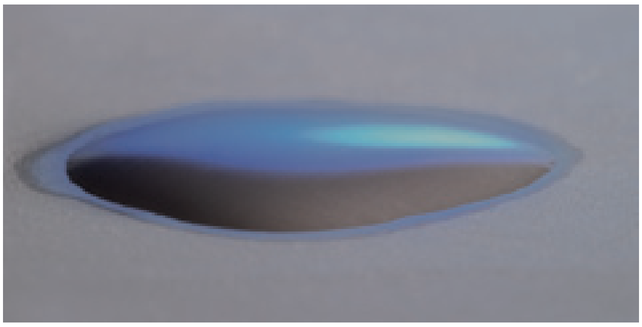
Note: If the scheduling of bonding operations on multi-part assemblies causes delay between pretreatment and bonding, optimum surface properties may be preserved by priming the bond surfaces immediately after pretreatment.

Test for a clean bond surface

The water break test is a simple method to determine whether the surface to be bonded is clean. It is best suited to metals.



Bad wetting



Good wetting

If a few drops of distilled water applied to the surface spread it – or if, on drawing the surface from distilled water, the water film does not break up into droplets – then the surface may be assumed to be acceptably free of contamination. Uniform wetting of the surface by distilled water indicates that it will probably be likewise wetted by adhesive.

It must be borne in mind that certain plastics, even when clean, may not be wetted by distilled water, but will be wetted by adhesive. Furthermore, it should be noted that a satisfactory wetting provides no information with regards to the potential bond strength. At most it is a necessary – but not sufficient – requirement for the achievement of high bond strengths.

The surface tension of plastic materials cannot be directly measured and is therefore usually determined indirectly by contact angle methods. Several standard methods have been developed to respond to the different types of substrates to be evaluated (refer to literature, ie -the Adhesives Technology Handbook – William Andrew Editions for more detailed information).

Surface preparation and pretreatments

2-2 Surface preparation methods

Degreasing methods

D

Removal of oil or grease residues is key but should be combined to other surface preparation for optimal bonding:

- **> Degreasing only (good)**
- **> Degreasing, mechanical abrasion followed by loose particles removal (very good)**
- **> Degreasing and chemically pretreat (excellent)**

The removal of all traces of oil and grease from the surfaces to be bonded is essential. Degreasing by one of the methods given below should be carried out even when the surfaces to be bonded appear clean.

> Vapor degreasing
The parts are suspended in a vapor degreasing unit, using common degreasing solvent such as Acetone, MEK, Ethanol or Isopropanol. The unit may include a compartment to enable initial washing in the liquid solvent.

> Solvent immersion
Where a vapour degreasing unit is not available, immerse successively in two tanks each containing the same degreasing solvent. The first tank acts as a wash, the second as a rinse. When the solvent in the wash tank becomes heavily contaminated, the tank is cleaned out and refilled with fresh solvent. This tank is then used for the rinse, and the former tank for the wash.

> Brush or wipe
Brush or wipe the joint surfaces with a clean brush or cloth soaked in a commercial degreasing solvent. For fine work, washing down with solvent applied by aerosol spray may be a more suitable alternative; this technique also ensures that the solvent used is perfectly clean. Allow to stand for a minute or two to permit complete evaporation from the joint surfaces. A wide range of proprietary solvent degreasing agents with low hazard ratings are now available. These should be used in accordance with the manufacturer's instructions.

> Detergent degreasing
Scrub the joint surfaces in a solution of liquid detergent. Non-ionic detergents give generally good results. Wash with clean hot water and allow to dry thoroughly – preferably in a stream of hot air from, e.g. a domestic forced-air heater.

> Alkaline degreasing
Alkaline degreasing is an alternative method to the detergent degreasing. The ingredients may be selected from a wide range of compounds including sodium or potassium hydroxide, carbonates, phosphates, borates, complexing agents and organic surfactants. They can be used hot or cold with or without applied current. There should be very thorough washing, and possibly neutralisation to remove residual traces of alkaline cleaners. It is recommended to use proprietary products and to follow the manufacturer's instructions for use.

> Ultrasonic degreasing
Ultrasonic degreasing may also be employed and is typically used for the preparation of small specimens (by ultrasonic vapour degreasing or solvent immersion).

Abrading methods

A

Lightly abraded surfaces provide better anchoring to adhesives than highly polished surfaces.

If performed, the abrasion surface treatment must be followed by a further treatment to ensure complete loose particles removal. For example:

- **> Repeat the degreasing operation, degreasing liquids must be clean (good)**
- **> Lightly brush with a clean soft brush (very good)**
- **> Vacuum clean the surface with a suitable industrial vacuum cleaner (excellent)**

> Metal surface preparation

Remove surface deposits, e.g. oxidation, corrosion or mill scale, preferably by grit blasting using a suitable abrasive media. For most materials the preferred grits are fused alumina and, less commonly, silicon carbide (ferrous grits such as chilled iron must be restricted to mild steels and cast irons; their use on other metals may promote corrosion). Fused alumina is the mostly used abrasive for aluminum alloys and stainless steels. Silicon carbide is sharper, but it is more expensive and also more friable. Silicon carbide is used on certain special alloys likely to react adversely with any residual fused alumina at temperatures they may be exposed to under service conditions. The use of silicon carbide may be preferable when the materials to be abraded are either soft or extremely hard.

Choice of grit size depends on various factors: metal to be grit blasted, type of grit blasting equipment, pressure and angle of blast impact, and time of treatment. Grits from 46 to 120 mesh (350 to 125 μm) are usually adequate for most applications, however the optimum grit size for specific applications may have to be determined by trials or based on past experience. In general for soft materials, the optimum grit size will be towards the fine end of the range.

If grit blasting equipment is not available or the metal is too thin to withstand blast treatment, then clean the joint surfaces with a wire brush, or with abrasive cloth or waterproof abrasive paper (alumina or silicon carbide abrasive). Wetting the wire brush – or the abrasive cloth or paper – assists removal of contaminants and reduces dust. Dry, if necessary, and remove all loose particles.

Note: Painted surfaces should be stripped of paint; otherwise the strength of the joint may be limited by comparatively low adhesion to metal.

> Plastics surfaces

Remove the top layer of plastics surfaces to ensure elimination of all traces of release agent. As with metals, abrasion by grit blasting is in general the best method; the alternative is to use abrasive cloth or paper. After abrasion, all loose particles must be removed.

Note: Removal of loose particles from plastic surfaces is best carried out by second and third methods previously introduced. As polymeric materials often generate static electricity which may promote dirt particles pick up, the parts must be bonded as soon as possible after cleaning. Use of degreasing liquids on certain plastics may impair the surface profile produced by the abrasion treatment. Since plastics are poor heat conductors, care must be taken to keep blasting times as short as possible. For composites pretreatment, cryoblasting may also be used which involves use of solid carbon dioxide pellets as the blasting medium. Use of peel (or tear) plies is also often used in composite industry to get ready to bond surface: peel plies are special fabrics applied on the surface of the composite before cure and peeled off after cure, leaving a rough surface better suited for bonding.

Surface preparation and pretreatments

2-2 Surface preparation methods

Special pretreatments

SP

The surface preparation described previously, i.e. degreasing alone or degreasing followed by abrasion and removal of loose particles, is sufficient for most adhesive work.

However in order to obtain maximum strength, reproducibility and long-term resistance to deterioration, a chemical or electrolytic pretreatment may be required.

Examples of these special pretreatments are described in the annexes.

Metal substrates

> Acid etching

The visible surface of any metal substrate is rarely made of pure metal and is far more likely to be a combination of oxides, sulphides, chlorides and other atmospheric contaminants resulting in a surface which is mechanically weak. Acid etching is a well-established method of removing surface oxidation layers in general weakly attached to the metal surface and replace it with an oxide layer which is mechanically and chemically compatible with the adhesive. Hence, different acid treatments are applied to different metal adherends, for example, chromic acid for aluminum, sulphuric acid for stainless steel, and nitric acid for copper.

> Anodising

Anodising is being used extensively by the aerospace industry as a surface pretreatment for aluminum and titanium alloys. The purpose of anodising is to deposit a porous oxide layer on top of the oxide layer formed after etching. The porous oxide layer enables adhesive (or primer) to penetrate the pores readily to form a strong bond. Hard anodised aluminum alloy requires stripping either by abrasive blasting or by etching: the unstripped metal is unsuitable for bonding.

> Application of a primer

Primer application is another form of surface pretreatment mainly used for materials such as metals, glass and ceramics. Generally, the primer is the final stage of a multistage pretreatment process. Some substrates have ”difficult to bond” surfaces (e.g. copper). The primer, which is effectively a solvent based version of the adhesive, readily wets the substrate. Once the adhesive is applied to a chemically compatible surface, it will form a strong bond after curing.

Care must be taken in the preparation of chemical pretreatment solutions, not only because of the handling hazards, but also because incorrect preparation may lead to bond strengths inferior to those that would have been obtained without chemical treatment.

Time of application is also critical: a too short application does not sufficiently activate the surfaces, whereas an excessively long exposure to the chemical(s) may result in chemical reaction products which will interfere with adhesion.

Upon completion of a chemical pretreatment, a thorough washing of the surfaces with sufficient clean water is standard practice. For the final rinse, the use of de-ionised (demineralized) water is strongly recommended.

Plastics / composites substrates

The type of polymer and the manufacturing process used to make the substrates to be bonded may influence the effectiveness of the chemical pretreatment. It is also advisable to test whether the quality of the pretreatment is dependent on the specific immersion time. Acid pretreatment can also be applied to certain plastics, e.g. chromic acid is used to surface treat polyolefins.

In addition to the normal mechanical and chemical methods of pretreatment, certain plastics can be pretreated using the following methods, all of which cause a change in the surface texture of the substrate. The change is brought about by the interaction of highly energised species within the substrate surface.

> Low pressure plasma
A gas is excited by applying a high frequency and high voltage between electrodes in a low pressure chamber. The advantage of this method is that it allows a surface treatment by different plasmas of argon, ammonia, oxygen or nitrogen making the process suitable for a range of substrate types.

> Atmospheric plasma
It is created in air at atmospheric pressure (no gas can be associated), and the beam generated does not have any electrical potential. The benefits of this method are similar to the previous one.

> Corona treatment
Under normal atmospheric pressure, a high voltage discharge creates oxgen and ozone molecules which will lead to the activation of the plastic surface by oxidation.

> Flame treatment
The effect of a flame treatment is to oxidise the surface layer to produce polar groups hence creating a surface better suited to wetting by the adhesive. This method of surface pretreatment has been applied successfully to polyethylene / polypropylene. The parameters which can influence the quality of the flame treatment include type of gas, gas / air (oxygen) ratio, flow rate, exposure time and distance between flame and substrate.

All these methods have limited stability which can vary from hours to weeks according to substrate. Further information can be found in ISO 13895.

Surface preparation and pretreatments

2-3 Appropriate surface treatment

For metals

Most common industrial materials likely to be bonded are covered in the following pages (please refer to table of content for details).

Engineers who are considering the bonding of materials not covered by this manual are invited to submit enquiries concerning appropriate pretreatments to our technical staff.

The wide range of individual alloys (and the variety of surface structures caused by heat treatments) within each metal group precludes standardising on one pretreatment for each.

The following pretreatments are well established but on occasion a different pretreatment (not described in this manual) may prove more effectiveness. This can be shown only by comparative testing – using materials from the batch of metal components to be bonded and the type of adhesive specified for the work.

Additional data on pretreatment of metals is given in ISO 4588 and DEF standard 03-2/3. The recommendations given in this brochure for pretreatment of metals are in compliance with the above.

Substrate	Preferred pretreatment (state of the art)	Alternative solution	Remarks
Aluminum and alloys non - anodised	D SP	D A	SP: anodise with chromic or phosphoric acid.
Aluminum and alloys anodised	None	None	Chromic acid or phosphoric acid anodised material has the optimum surface properties for bonding directly after completion of the anodising process. No pretreatment is needed, but the material must be bonded within a few hours after anodising.
Aluminum and alloys hard anodised	D SP	D A	SP: requires stripping either by abrasive blasting or by etching (annex Etchant 1). The unstripped metal is unsuitable for bonding. Aluminum alloy anodised by the normal chromic acid or sulphuric acid methods and sealed, may be bonded after degreasing and light abrasion.
Cadmium	D SP	D A	SP: electro-plate with silver or nickel.
Cast iron	D A	-	-
Copper and copper alloys	D SP	D A	SP: etching solution (annex Etchant 2).
Chromium	D SP	D A	SP: etching solution (annex Etchant 3).
Galvanised surfaces			See zinc and zinc alloys.
Gold	D	-	-
Lead	D SP	D A	SP: etching solution (annex Etchant 4).
Magnesium and magnesium alloys	D SP	D A	SP: etching solution (annex Etchant 5).
Nickel and nickel alloys	D SP	D A	Etch for 5 seconds in concentrated nitric acid. Wash with clean cold running water, followed by clean hot water, and dry with hot air.
Silver	D A	-	-
Steel mild	D SP	D A	SP: etching solution (annex Etchant 6).
Stainless steel	D SP	D A	SP: etching solution (annex Etchant 7).
Tin	D A	-	-
Titanium and titanium alloys	D SP	D A	SP: etching solution (annex Etchant 8).
Tungsten and tungsten carbide	D SP	D A	SP: etching solution (annex Etchant 9).
Zinc and zinc alloys	D A	-	Apply the adhesive immediately after surface preparation.

D *Degreasing* A *Abrading* SP *Special pretreatment*

Surface preparation and pretreatments

2-3 Appropriate surface treatment

For plastics and composites

> Thermosets (eg epoxy, polyurethane, polyester…)
Moldings, castings, laminates and the like can usually be bonded without difficulty. However in order to ensure good bond strength, all surface contaminants (e.g. residual release agent) must be removed from the joint surfaces before the adhesive is applied. The surfaces must be either abraded with emery cloth or bead-blasted, or they must be cleaned with an organic solvent such as acetone, methylethyl ketone, etc. Abrading or bead blasting is highly recommended for molded parts since their surfaces may otherwise repel the adhesive.

> Thermoplastics
Although these are often difficult to bond, the wide range of Huntsman industrial adhesives is providing a solution in most of the cases. This is especially true for pretreated thermoplastics. On the other hand, whilst some types of thermoplastics can be bonded successfully, others will produce limited bond strength and one can see significant variations with the properties which affect the adhesive bond strength within the same type of material.

Some specialty adhesives have been developed, however they usually prove to be inadequate when thermoplastics have to be bonded to materials such as wood, metal, etc.

Huntsman industrial 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 Huntsman industrial adhesives.

Substrate	Preferred pretreatment (state of the art)	Alternative solution	Remarks
ABS	D SP	D A	SP: etching solution (annex Etchant 10) or plasma treatment.
Cellulose based polymers	D A	-	Warm preferably for 1 hour at 100°C and apply the adhesive before the material cools completely down to room temperature.
Composites (fibre reinforced thermosets)	D A	D SP	Alternatively, design the laminate in such a way that a 'tear ply' of fine close weave polyester fabric is placed at the surface to be bonded. (The ply becomes part of the laminate on curing.) Just prior to bonding, tear off the ply to expose a fresh clean bond surface on the laminate. SP: plasma treatment.
Decorative and industrial laminates	D SP	D A	SP: pretreat using corona / plasma treatment.
Polyacetal (POM)	D SP	-	SP: etching solution (annex Etchant 10).
Polyamides (Nylon)	D SP	D A	SP: pretreat using corona / plasma treatment.
Polyacrylics (PMMA…)	D A	D SP	For optimal results, it is recommended to stress relieve the material by annealing. SP: plasma treatment.
Polycarbonate	D SP	D A	SP: pretreat using corona / plasma treatment.
Polyesters (unsaturated thermosets)	D A	-	See composites (fibre reinforced thermosets).
Polyesters thermoplastic moldings and films	D SP	D A	SP: etching solution (annex Etchant 11). Alternative: corona / plasma treatment.
Polyetheretherketone (PEEK)	D SP	D A	SP: Pretreat using corona / plasma treatment.
Polyimide	D SP	D A	SP: pretreat using corona / plasma treatment.
Polyolefin (PP, PE)	D SP	-	SP: pretreat using flame / plasma treatment. Lightly flame treat with a waving motion in an oxidising gas flame until the surface is shiny. Proprietary primers for polypropylene are available which provide an alternative to flame and plasma pretreatments.
Polyphenylene oxide (PPO)	D SP	D A	SP: pretreat using corona / plasma treatment.
Polystyrene	D A	-	-
Polyurethane	D SP	D A	SP: pretreat using corona / plasma treatment.
PTFE and similar fluorocarbon plastics	D SP	-	Fluorocarbon based polymers cannot normally be bonded in the untreated condition. There are, however, specialised processes (involving flame oxidisation or exposure to dispersions of metallic sodium) for treating the surfaces of fluorocarbon polymers. Pretreated PTFE using such processes is available from various suppliers.
PVC	D A	-	-
SMC / BMC			See composites (fibre reinforced thermosets).

D *Degreasing* A *Abrading* SP *Special pretreatment*

Surface preparation and pretreatments

2-3 Appropriate surface treatment

For miscellaneous materials

For non metallic or non plastic substrates, surface preparation are also required for optimum bonding.

The table here after provides solutions for mineral materials, rubbers, leather and wood.

Substrate	Preferred pretreatment (state of the art)	Alternative solution	Remarks
Bricks and other fired non-glazed building materials	D A	-	Brush with a wire brush and remove dust.
Carbon	D A	-	Abrade with fine abrasive cloth or paper and remove dust.
Ceramics	D A	-	Abrade with a slurry of silicone carbide powder and water.
Concrete and mortar	D A	D SP	Even where concrete is sound, it should be pretreated wherever practical 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 3mm - or more - of all surfaces to be bonded, then remove dust preferably by vacuum cleaner; or 2. Sand-blast about 1.5mm off all surfaces to be bonded, then remove dust preferably by vacuum cleaner; or 3. SP: etching solution (annex Etchant 12).
Earthenware	D A	-	-
Friction materials (brake pads and linings)	D A	-	-
Glass	D SP	D A	SP: pretreating the surface with a silane based primer will increase the bonding performance. Alternatively warm for 1/2 hour at 100°C and apply the adhesive before the glass cools down completely to room temperature.
Graphite	D A	-	Abrade with fine abrasive paper or cloth and remove dust.
Jewels	D	-	-
Leather	D A	-	Roughen with abrasive paper & remove loose particles
Paints (cataphoretic / powder coatings)	D A	-	-
Plaster	D A	-	Allow the surfaces to dry thoroughly. Smooth with fine abrasive paper or cloth and remove dust.
Rubber	D SP	D A	SP: etching solution (annex Etchant 13).
Stonework	A	-	Allow the surfaces to dry thoroughly. Brush with a wire brush and remove dust.
Wood	A	-	Ensure the wood is dry. Plane or abrade with abrasive paper and remove dust.

D *Degreasing* A *Abrading* SP *Special pretreatment*

Etchants compositions

Etchant 1 (aluminum etching)

Composition

Potassium dichromate or sodium dichromate	2 kg
Concentrated sulphuric acid (specific gravity 1.84)	10 litres
Distilled/de-ionised water	30 litres

Solution preparation: Stir continuously whilst adding the concentrated sulphuric acid to 60% of the total water volume. Add dichromate. Stir to create a solution. Finally add the remaining water.

Etchant 2 (copper and copper alloys etching)

Composition

Concentrated nitric acid (specific gravity 1.42)	5 litres
Distilled/de-ionised water	15 litres

Etch for 30 seconds at room temperature in the above described etching solution. Rinse with clean cold running water. Do not allow to dry. Immerse for 2-3 minutes at 95-100°C in a solution of:

Composition

Sodium hydroxide	0.1 kg
Sodium chlorite (NaCl technical)	0.6 kg
Trisodium phosphate (Na_3PO_4 anhydrous)	0.2 kg
Distilled/de-ionised water	20 litres

Rinse with plenty of clean cold water and dry promptly with a room temperature air stream (the use of hot air may cause staining of the surfaces).

The above two-stage chemical pretreatment gives, in general, better bond strengths than the ammonium persulphate pretreatment below. This however offers the advantage of simplicity and the achievable bond strength may be adequate for a specific purpose.

Etch in a 25% solution of ammonium persulphate: Immerse for 30 seconds at room temperature, wash with plenty of clean cold water and dry promptly with a room temperature air stream. (The use of hot air may cause staining of the surfaces).

Etchant 3
(chromium etching)

Composition

Concentrated hydrochloric acid (specific gravity 1.18)	4.25 litres
Distilled/de-ionised water	5 litres

Immerse for 1-5 minutes at 90-95°C, rinse with clean cold running water, followed by clean hot water, and dry with hot air.

Etchant 4
(lead etching)

Composition

Concentrated nitric acid (specific gravity 1.42)	1 litres
Distilled/de-ionised water	9 litres

Immerse for 10 minutes at 45-55°C, rinse with clean running water, followed by clean hot water, and dry with hot air.

Etchant 5
(magnesium and magnesium alloys etching)

Composition

Sodium sulfate anhydrous	0.2 kg
Calcium nitrate	0.2 kg
Chromium trioxide	2.2 kg
Distilled/de-ionised water	12 litres

Immerse in sodium hydroxide solution (1 part to 12 parts) for 10 minutes at 70-75°C, wash thoroughly in cold tap water. Immerse in etchant 5 for 10 minutes at room temperature. Rinse thoroughly with cold tap water. Final rinse with distilled or de-ionised water. Dry in hot air and bond immediately.

Etchant 6
(steel-mild etching)

Composition

Orthophosphoric acid (specific gravity 1.7)	10 litres
Industrial methylated spirit	20 litres

Immerse for 10 minutes at 60°C, remove from the solution and then, under clean cold running water, brush off the black deposit with a stiff-bristle nylon brush. Absorb residual water by wiping with a clean cloth soaked with clean industrial methylated spirit or isopropanol. Heat for 1 hour at 120°C.

Surface preparation and pretreatments

2-4 Annexes

Etchant 7
(stainless steel etching)

Composition

Oxalic acid (HOOC-COOH, $2H_2O$)	5 kg
Concentrated sulphuric acid (specific gravity 1.84)	16 litres
Distilled/de-ionised water	35 litres

Etch for 5-10 minutes at 55-65°C.
Prior conditioning (e.g. passivation) of the steel surface may delay the reaction between steel and etch solution. The etch treatment should be timed from the onset of the reaction. Rinse with clean cold running water, then remove the black deposit* by immersing for 5-20 minutes at 60-65°C in the sulphuric acid + sodium dichromate (or chromium trioxide) etch specified for aluminium and aluminium alloys.

*Alternatively, remove the black deposit by brushing, under clean cold running water, with a stiff-bristle nylon brush, and dry with hot air.

Note: As wide variations in the composition of stainless steel can be encountered, prior testing should be performed to determine the optimum immersion conditions and etching solution component concentration. Etching baths used for the pretreatment of aluminium alloys must not be used concurrently for the pretreatment of steel.

Etchant 8
(titanium and titanium alloys etching)

Composition

Concentrated nitric acid (specific gravity 1.42)	9.5 litres
Hydrofluoric acid (specific gravity 1.17)	0.85 litre
Distilled/de-ionised water	40 litres

Etch for 1-2 minutes at room temperature. Wash with clean cold running water, then immerse for 2-3 minutes at room temperature in a solution of:

Composition

Trisodium phosphate (Na_3PO_4, $2H_2O$)	1.75 kg
Potassium fluoride (KF, $2H_2O$)	0.68 kg
Hydrofluoric acid (specific gravity 1.17)	1 litre
Distilled/de-ionised water	40 litres

Rinse with clean cold running water, immerse in clean de-ionised water at 55-65°C for 15-20 minutes, remove, rinse with clean cold running water (brush off any remaining deposit with a clean stiff-bristle nylon brush) and dry with hot air. The temperature of the hot water and air must not be greater than 65°C.

Frequent renewal of the de-ionised water is highly recommended. Renewing is essential if turbidity appears.

Etchant 9
(tungsten and tungsten carbide etching)

Composition

Caustic soda (sodium hydroxide)	15 kg
Distilled/de-ionised water	35 litres

Use a stress-relieved mild-steel container: aluminium, tin and zinc-coated, galvanised or tinned ware are unsuitable for caustic soda. Mixing procedure: slowly sprinkle while stirring, flake or pearl caustic soda onto the cold water. Continue stirring until the caustic soda is dissolved. Immerse for 10 minutes at 80-90°C, rinse with clean cold running water, followed by clean hot water and dry with hot air.

Etchant 10
(ABS etching)

Composition

Potassium dichromate or sodium dichromate	1 kg
Concentrated sulphuric acid (specific gravity 1.84)	10 litres
Distilled/de-ionised water	30 litres

Immerse for 15 minutes at room temperature, rinse with clean running water, followed by clean hot water, and dry with hot air.

Etchant 11
(Thermoplastic polyesters etching)

Composition

Caustic soda	2 kg
Distilled/de-ionised water	8 litres

Immerse for 6 minutes at 75-85°C, wash with clean running cold water, followed by clean hot water, and dry with hot air.

Etchant 12
(Concrete / mortar etching)

Composition

Hydrochloric or sulphamic acid	1 litre
Distilled/de-ionised water	10 litres

Etch (1litre per square meter, 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 rinse with 1% ammonia solution followed by clean water is always a good practice to ensure thorough neutralisation. Allow the surface to dry thoroughly. Remove dust preferably by vacuum cleaner.

Surface preparation and pretreatments

2-4 Annexes

Etchant 13
(Rubber bleaching)

Composition modified bleach solution

Sodium hypochlorite (standard household bleach)	300 ml
Concentrated hydrochloric acid (specific gravity 1.18)	50 ml
Distilled/de-ionised water	10 litres

Prepare the modified bleach solution by pouring the water into a clean container made of plastic, glass or similar inert ware. While stirring the water, add the concentrated hydrochloric acid in a slow steady stream. Then add the household bleach, stirring it thoroughly into the diluted acid. Never pour the household bleach into the acid (or the other way round) without adding the water first. Immerse for 1-3 minutes at room temperature, wash with cold clean water, followed by clean hot water, and dry with hot air.

Alternative solution is to use concentrated sulphuric acid (specific gravity 1.84). Immerse for 2-10 minutes at room temperature, rinse with clean cold running water, followed by clean hot water, and dry with hot air.

Environment, Health and Safety (EHS) considerations

This manual lists many chemicals which require cautionary labelling under local legislation in many countries.

It is important to read, and fully understand, the suppliers' technical and safety data sheets, making sure all precautions are in place and the necessary personal protective equipment is available before commencing work.

Acids, caustic soda, etc...

Concentrated acids, oxidising agents e.g. dichromates, and hot caustic soda solution are highly corrosive chemicals. Spillages and splashes can cause severe damage to eyes and skin, and attack ordinary clothing. Fine particle mists resulting from the stirring or agitation of the solutions can present a severe respiratory hazard. Operators must wear personal protection e.g. goggles, protective clothing, respirators.
Important: Never pour water into acids. Always pour the acid in a slow steady stream into the water, with continuous stirring. Bear in mind that the handling hazard is intensified when the acid is hot.

Chromium compounds

These materials have health hazards ranging from harmful to those that are highly toxic and carcinogenic. Ensure that the latest safety data is available for the particular compound chosen.

Sodium

Pieces of sodium react violently and may explode on contact with water, emitting flammable hydrogen gas. Sodium burns spontaneously in air and vapours ignite at room temperature. It also reacts explosively with many aqueous solutions and some organic solvents – mainly chlorinated hydrocarbons – and reacts vigorously with many others on heating. Sodium reacts incandescently with some (mostly halogenated) compounds. Mixtures of sodium and metal halides are sensitive to mechanical shock. Sodium is highly toxic and corrosive, causing severe thermal and caustic burns to tissues in the presence of moisture.

Waste disposal

Used etching solutions may contain some compounds which are harmful to human health and the environment. These solutions as well as other waste and by products resulting from the surface preparation process should always be disposed of in a safe manner and in accordance with all the state and local regulations.

Huntsman industrial adhesives

Huntsman resins and hardeners can be handled safely provided that adequate precautions normally taken when handling chemicals are observed. The individual product safety data sheet should be read and understood prior to handling these materials and the required personal protective equipment (e.g. safety glasses or goggles, chemical resistant gloves,…) should be used to prevent any skin and eye contact.

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