

TALAT Lecture 4704

Surface Preparation and Application Procedures

12 pages, 13 figures

Basic Level

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Objectives:

- to describe the important aspects of surface preparation and pretreatments for adhesive joining of aluminium parts
- to illustrate the methods and equipment necessary to obtain good adhesive bonds

Prerequisites:

- general background in production engineering and material science
- background in mechanics and polymer science

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4704 Surface Preparation and Application Procedures

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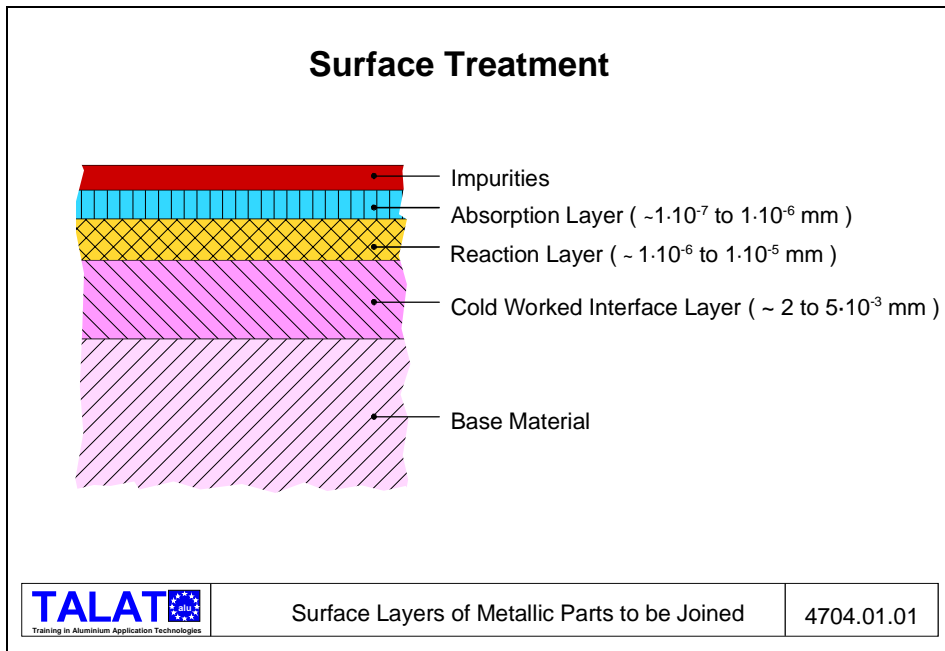
4704.01 Surface Preparation of Metallic Parts to be Joined

- Surface layers of metallic parts to be joined
- Surface treatment processes
- Methods of surface pretreatment
- Surface pretreatments for aluminium
- Correlation between adhesive strength and surface roughness

Surface layers of metallic parts to be joined

The surfaces of parts which have to be joint are treated prior to joining in order to have an optimal adhesion force between joint part surface and the adhesive layer.

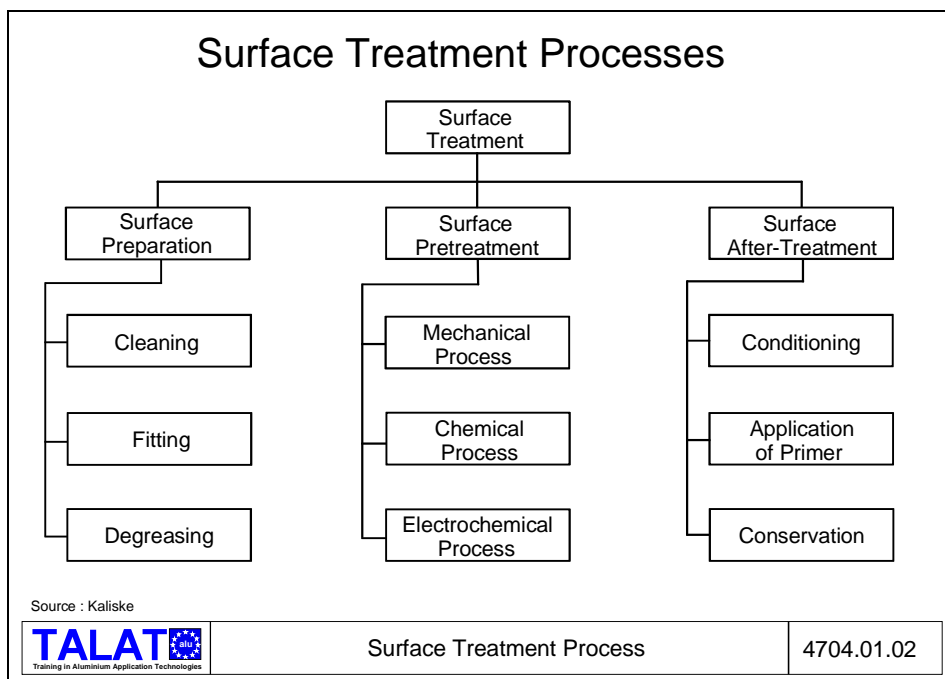
For this purpose it is absolutely necessary to first remove impurities in an undefined layer thickness (i.e., dust, dirt, oil, grease, fat, water) and the inactive adsorption layer created by foreign molecules (i.e., water, gases) (**Figure 4704.01.01**).



Surface treatment processes

The whole surface treatment can be subdivided into a preparation, pretreatment and after-treatment operation.

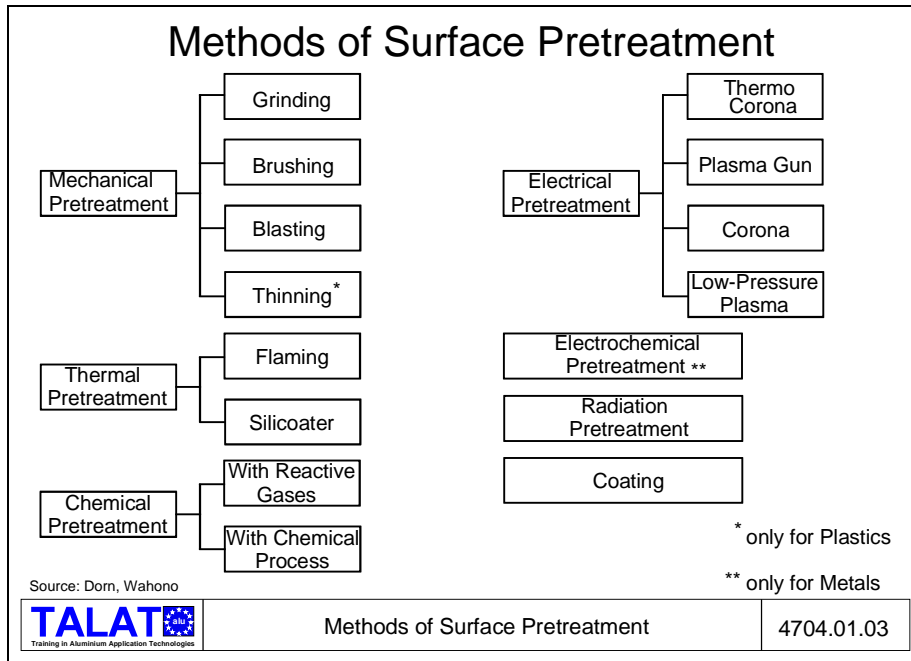
In general, an active surface for adhesives can be created by cleaning and increasing the surface area, creation of lattice defects on the surface and changing the chemical structure of the surface.



In cases where a longer time-lapse is expected between the surface treatment and the adhesive joining, the surface of the joining parts should be conserved, using for example, a primer (**Figure 4704.01.02**).

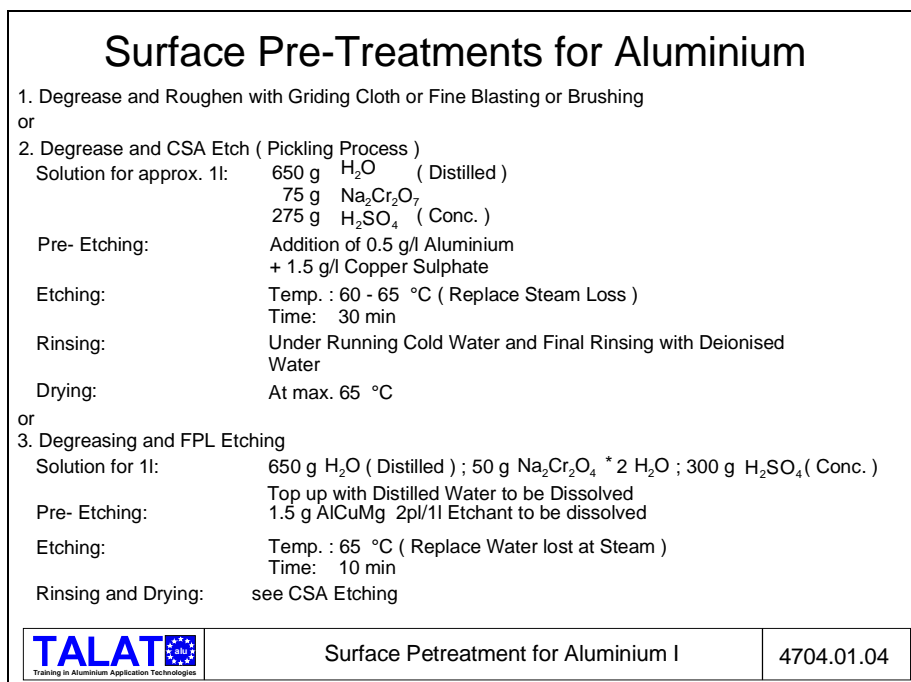
Methods of surface pretreatment

Because of current ecological reasons, there is an increasing tendency to replace wet chemical surface pretreatment processes by mechanical, electrical and dry chemical pretreatment methods (**Figure 4704.01.03**).



Surface pretreatments for aluminium

The list in **Figure 4704.01.04** and **Figure 4704.01.05** depicts processes, including their parameters, which have proven to be successful for use with aluminium materials.



Surface Pre-Treatments for Aluminium

or

4. Degrease and CSB Etching and Chromic Acid Anodising (CAA)

Solution for Approx. 1 l:	40g CrO	Cathode:	Stainless Steel (V2A)
Temp.:	40 °C (± 2 °C) (replace water losses)	Time:	from 0 to 40 V in 10 min 40 V 20 min
Rising:	10 min in distilled H ₂ O at 40 °C		from 40 to 50 V in 5 min 50 V 5 min
Drying:	at max. 40 °C		

or

5. Degrease and FPL Etching and Phosphoric Acid Anodising (PPA)

Solution for Approx. 1 l:	129g 85% H ₃ PO ₄ / 1 l H ₂ O	Cathode:	Stainless Steel (V2A)
Temp.:	RT	Time:	from 0 to 40 V in 10 min 40 V 20 min
Rising:	22 min in distilled H ₂ O at 40 °C		from 40 to 50 V in 5 min 50 V 5 min
Drying:	at max. 40 °C		



Surface Pretreatments for Aluminium II

4704.01.05

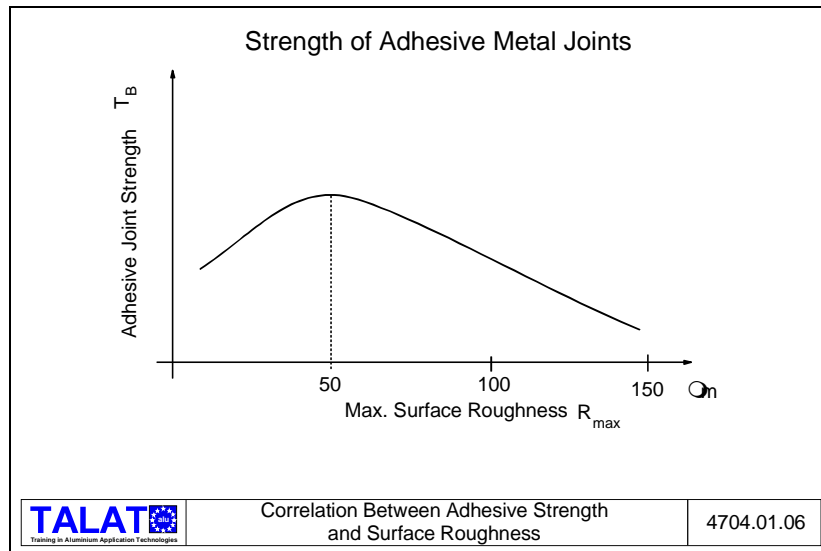
When used as the only surface pretreatment method, FPL-etching is inferior to the CSA-etching.

A CAA or PAA anodisation which follows, improves the long-term stability of the adhesive joint. Compared to the oxide layer created by the CAA process, the PAA oxide layer is thinner and more sensitive to mechanical damage, making it necessary to use a protective primer.

It must be stressed here, that etching solutions must be handled and later deposited with great care, especially since these may contain dangerous (partly cancerogenic) substances and the used solution may be dumped only in so-called "special" dumps.

Correlation between adhesive strength and surface roughness

In view of the attainable strength of the adhesive joint and the notch sensitivity of most aluminium materials, the mechanical surface pretreatment should deliver only a low maximum roughness (**Figure 4704.01.06**).

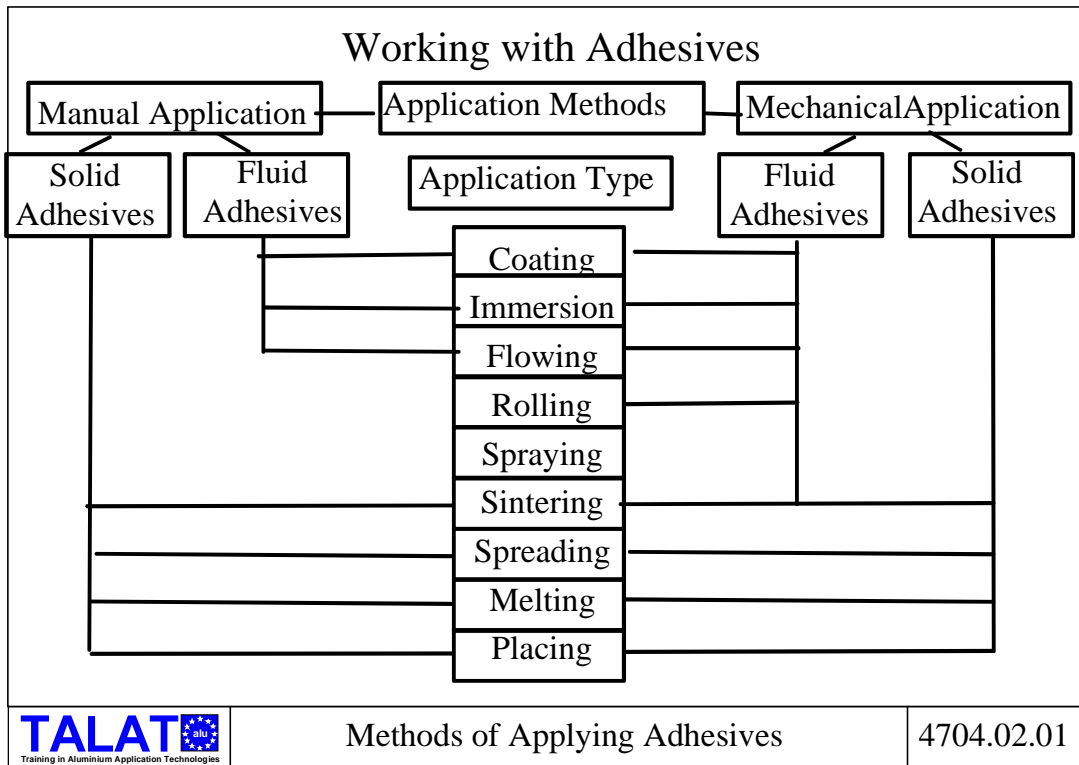


4704.02 Application Procedures

- Methods of applying adhesives
- Equipment for working adhesives
- Correlation between adhesive joint strength and adhesive layer
- Methods of applying pressure
- Correlation between adhesive joint strength and applied pressure
- Correlation between hardening temperature, hardening time and adhesive joint strength

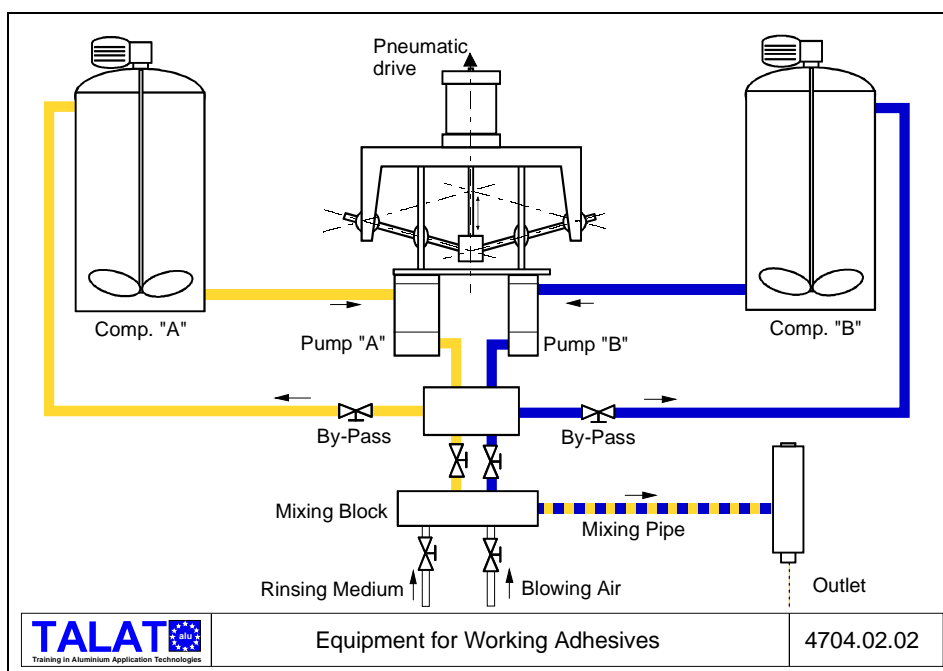
Methods of applying adhesives

The possible application processes, depending on the consistency (solid or fluid) of the adhesive and on the application method used (manual or mechanised), have been listed in **Figure 4704.02.01**.



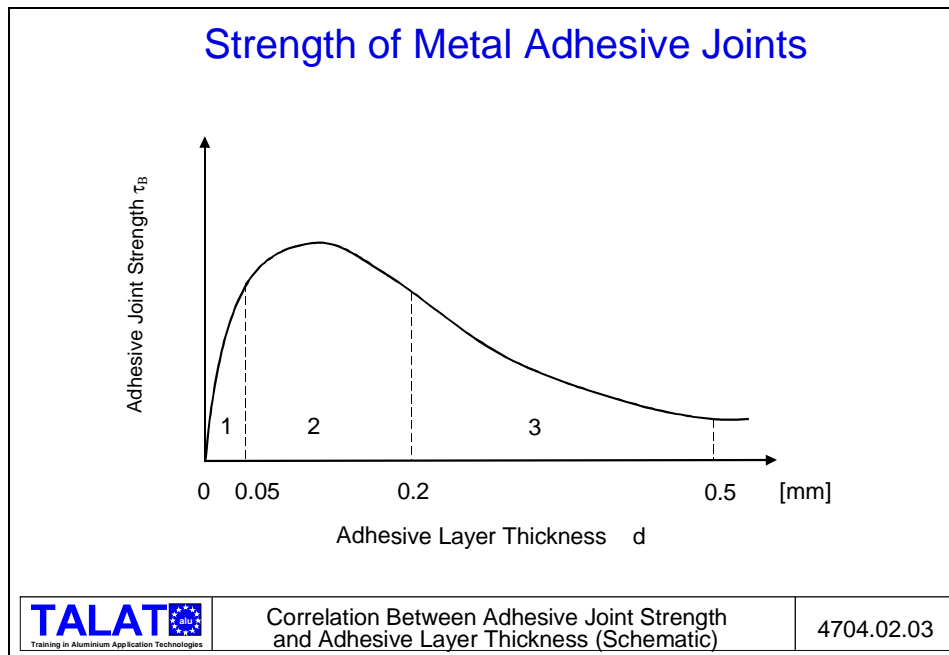
Equipment for working adhesives

A large variety of equipment (including robots) is available for working with the adhesives. The working principle of a 2-component dosing and application machine is illustrated in **Figure 4704.02.02**.



Correlation between adhesive joint strength and adhesive layer

Generally, an adhesive layer thickness of about 50 to 200 μm should be strived at (exception: CA adhesives). It should be remembered that the adhesive layer thickness depends, to a large extent, on the pressure applied during setting (curing) (Figure 4704.02.03).



Methods of applying pressure

The possibilities of applying pressure during the hardening of the adhesive are illustrated in Figure 4704.02.04 and Figure 4704.02.05.

Most adhesives require only a contact pressure (about 0.1 N/mm^2). Adhesives, which react chemically and produce by-products during the curing (setting) process (i.e., PF adhesives), are an exception.

Working with Adhesives Methods of Applying Pressure - I

Wrong

Right

Pressure Application

Spot Weld,
Screw, Rivet

Weight-Loading

Spring Loading

	Methods of Applying Pressure - I	4704.02.04
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Working With Adhesives Methods of Applying Pressure - II

Autoclave Method

Tension Band

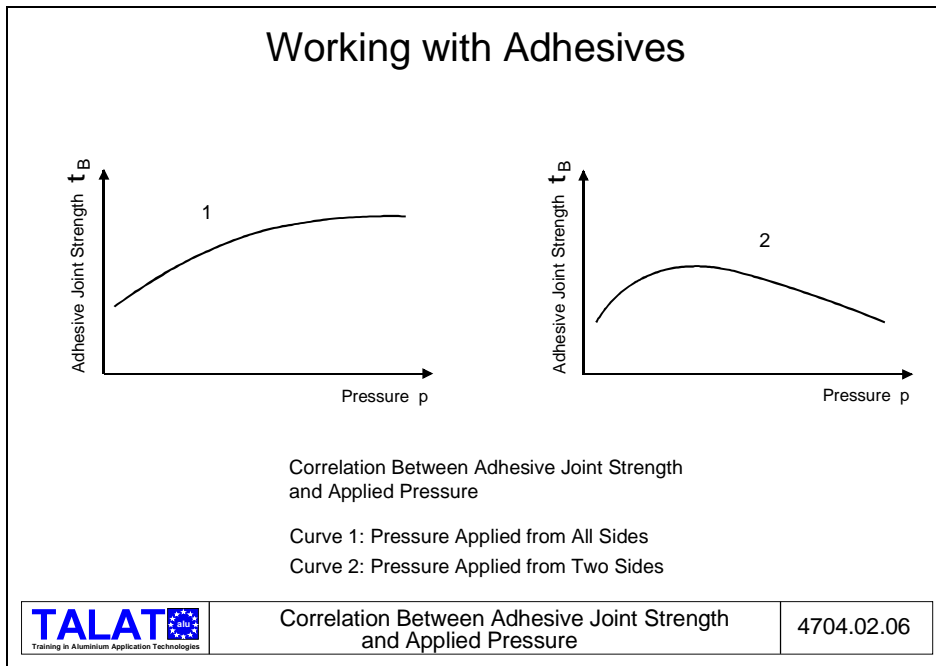
Pressure-Bag Method

Vacuum Method

	Methods of Applying Pressure - II	4704.02.05
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Correlation between adhesive joint strength and applied pressure

The method of applying pressure from all sides, like in the autoclave method, should be used preferably (**Figure 4704.02.06**).

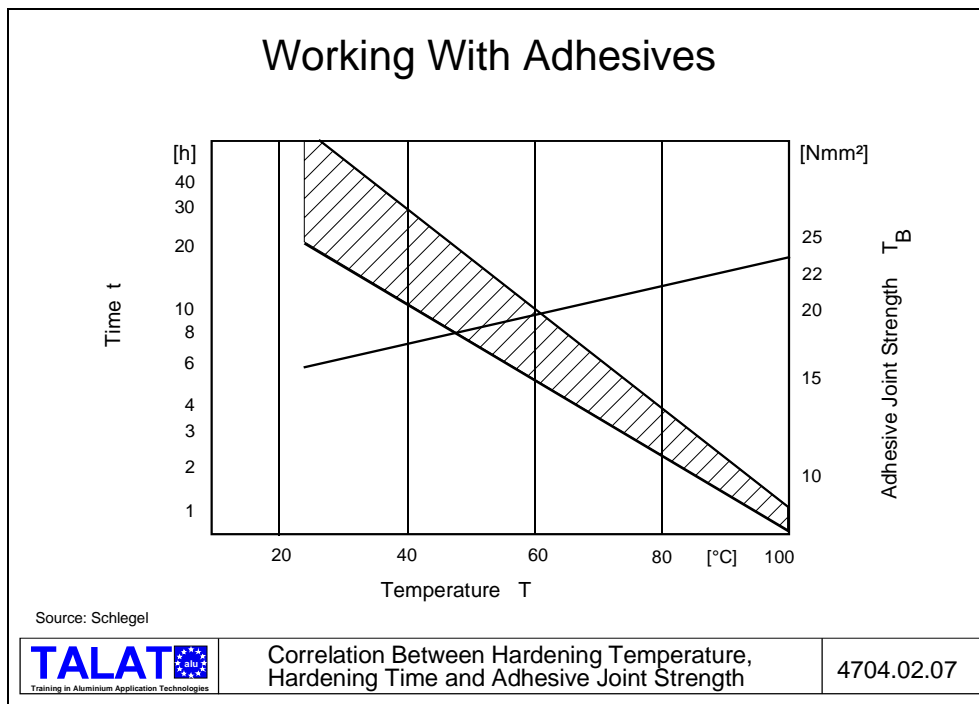


Correlation between hardening temperature, hardening time and adhesive joint strength

Usually a functional correlation exists between hardening time and hardening temperature (**Figure 4704.02.07**).

Especially in the case of cold-hardening adhesives, the strength can be increased by hardening at higher temperatures or by tempering (after the cold-hardening).

It should be noted that the temperature, pressure and time recommendations of the manufacturer apply for the adhesive layer. Heating times for the joining parts and for the adhesive equipment must be determined and considered.



4704.03 Literature/References

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4704.02.01	Methods of Applying Adhesives
4704.02.02	Equipment for Working Adhesives
4704.02.03	Correlation between Adhesive Joint Strength and Adhesive Layer
4704.02.04	Methods of Applying Pressure - I
4704.02.05	Methods of Applying Pressure - II
4704.02.06	Correlation between Adhesive Joint Strength and Applied Pressure
4704.02.07	Correlation between Hardening Temperature, Hardening Time and Adhesive Joint Strength